Proposal # 2001- K-205 (Office Use Only)

PSP Cover Sheet (Attach to the front of each proposal)

Proposal Title: The influence of discharge, temperature, and fine sediment on the hyporheic zone: intragravel conditions and anadromous salmonid egg survival.

Applicant Name: US Bureau of Reclamation and Deer Creek Watershed Conservancy (Joint Venture)
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Amount of funding requested: $ 623.083

Some entities charge different costs dependent on the source of the funds. If it is different for state or federal funds list below.

State cost ____________ Federal cost ____________

Cost share partners? X Yes No TOTAL **$198.150**

Identify partners and amount contributed by each Deer Creek Watershed Conservancy - $9,000; Sierra Pacific Industries - $9,150; US Bureau of Reclamation, Upper Columbia Area Office - $75,000 (Lab. Model); USBR Denver Technical Service Ctr. - $105,000 (Field Work).

Indicate the Topic for which you are applying (check only one box).

- ☐ Natural Flow Regimes
- ☐ Nonnative Invasive Species
- ☐ Channel Dynamics/Sediment Transport
- ☐ Flood Management
- ☐ Shallow Water Tidal/ Marsh Habitat
- ☐ Contaminants
- ☐ Beyond the Riparian Corridor
- ☐ Local Watershed Stewardship
- ☐ Environmental Education
- ☐ Special Status Species Surveys and Studies
- ☐ Fishery Monitoring, Assessment and Research
- ☐ Fish Screens

What county or counties is the project located in? Shasta and Tehama Counties

What CALFED ecozone is the project located in? See attached list and indicate number. Be as specific as possible: 3.1. Sacramento River - Keswick Dam to Red Bluff Diversion Dam and 7.4. Deer Creek.

Indicate the type of applicant (check only one box):

- ☐ State agency
- ☒ Public/Non-profit joint venture.
- ☐ Local government/district
- ☐ University
- ☐ Other:
- ☐ Federal agency
- ☐ Non-profit
- ☐ Tribes
- ☐ Private party

'Joint Venture - Federal Agency/Conservancy *(See* Attachment L)

Indicate the primary species which the proposal addresses (check all that apply):

- ☐ San Joaquin and East-side Delta tributaries fall-run chinook salmon
- ☐ Winter-run chinook salmon
- ☒ Spring-run chinook salmon
- ☐ Late-fall run chinook salmon
- ☐ Fall-run chinook salmon
- ☐ Delta smelt
- ☐ Longfin smelt
- ☐ Splittail
- ☐ Steelhead trout
- ☐ Green sturgeon
- ☐ Striped bass
- ☐ White Sturgeon
- ☐ All chinook species
- ☐ Waterfowl and Shorebirds
- ☐ All anadromous salmonids
- ☐ Migratory birds
- ☐ American shad
- ☐ Other listed T/E species:

Indicate the type of project (check only one box):

- ☒ Research/Monitoring
- ☐ Watershed Planning
- ☐ Pilot/Demo Project
- ☐ Education
- ☐ Full-scale Implementation

Is this a next-phase of an ongoing project? Yes ____ No _X_
Have you received funding from CALFED before? Yes ____ No _X_
If y es, list project title and CALFED number: Not Applicable
Have you received funding from CVPIA before? Yes ____ No _X_
If y es, list CVPIA program providing funding, project title and CVPIA number (if applicable): Not Applicable

By signing below, the applicant declares the following:

- The truthfulness of all representations in their proposal;
- The individual signing the form is entitled to submit the application on behalf of the applicant (if the applicant is an entity or organization); and
- The person submitting the application has read and understood the conflict of interest and confidentiality discussion in the PSP (Section **2.4)** and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent as provided in the Section.

Mark D. Bowen
Printed name of applicant

Dianne Grammer
Printed name of joint venture applicant

Mark D. Bowen
Signature of applicant

Dianne Grammer
Signature of joint venture applicant

Contents

EXECUTIVE SUMMARY

The title of this proposed research is "The influence of discharge, temperature, and fine sediment on the hyporheic zone: intragravel conditions and anadromous salmonid egg survival." And, the amount of funding requested is $623,083 total for three years of work.

The US Bureau of Reclamation (Reclamation) and the Deer Creek Watershed Conservancy (DCWC) submit this proposal for research. The principal investigator and primary contact is Mark D. Bowen, Ph.D., Fishery Biologist, PO Box 25007, US Bureau of Reclamation, Denver, CO, 80225-8290. Dr. Bowen's phone and FAX numbers are respectively (303)445-2222 and (303) 445-6328. Dr. Bowen's email address is mbowen@do.usbr.gov. This is a joint venture, the contact for the DCWC is the executive director, Dianne Gaumer, 580 Paseo Companeros, Chico, CA, 95928. Mrs. Gaumer's phone and FAX numbers are the same, (530) 891-8636.

The co-principal investigators are, in alphabetical order, Ray Bark, M.A., Biological Trainee, Reclamation-Denver, CO, Sandy Borthwick, M.S., Fishery Biologist, Reclamation-Red Bluff, CA, Walt Duffy, Ph.D., Leader, CA Fish and Wildlife Research Unit, Humboldt State University-Arcata, CA, Joseph Kubitschek, M.S., Hydraulic Engineer, Reclamation-Denver, CO, and S. Mark Nelson, M.S., Research Aquatic Biologist, Reclamation-Denver, CO.

The project locations are Deer Creek (Tehama Co.) and the mainstem of the Sacramento River between Keswick Dam and Red Bluff Diversion Dam (Shasta and Tehama Co.). The principal objective of this research project is to provide information regarding the influence of discharge, temperature, and fine sediments on anadromous salmonid' egg survival in the intragravel region known as the hyporheic zone (the area of ground- and surface-water mixing in the intragravel area of the stream bed). For Reclamation this information may be used to operate Reclamation dams in a manner that provides for anadromous salmonid egg survival. For the DCWC, this information may be used to determine the effects of land use and to provide data concerning the management goals of the DCWC.

The approach used is a comparative field approach and analytical laboratory experiments to provide ecosystem information (field data) and sufficient sample size (lab and field data) to distinguish hypotheses concerning the effect of discharge, temperature, and fine sediments on egg survival. The primary hypotheses are: does hyporheic flow direction and magnitude change with discharge, does hyporheic flow direction and magnitude influence fall- or spring-run chinook salmon, do Sacramento River hyporheic temperatures produce higher egg survival than Deer Creek temperatures in early-arriving fall chinook redds (early arriving fall chinook are defined as those fish spawning between October 1 and October 15), and does lower Sacramento River fine sediment deposition in anadromous salmonid redds produce higher egg survival than higher fine sediment loads in Deer Creek redds.

This research addresses a major uncertainty in the ecosystem management of the Sacramento River watershed, i.e. what influence do dam operations have on the hyporheic zone. We will collect valuable information necessary for the management of the ecosystem and that is directly applicable to CALFED ERP goals: At-Risk Species: the information we will collect will be generally applicable to listed fish species throughout the Sacramento-San Joaquin ecosystem; Ecosystem Processes and Biotic Communities: little is known of the abiotic or biotic conditions in the hyporheic zone where anadromous salmonids deposit and incubate eggs; and Habitats: this research addresses a habitat required by anadromous salmonids for successful reproduction. We will provide data to maintain water supplies and manage temperature and discharge from Shasta and Keswick Dams that improve chinook salmon egg survival.

PROBLEM STATEMENT

Manipulation of discharge and stream temperature may influence anadromous salmonids egg survival in redds. The problem is the relationship between discharge and egg survival is poorly understood especially via hyporheic flow conditions. The hyporheic is the zone where surface and ground waters mix. Furthermore, the change in water temperatures provided by the temperature control device (TCD) at Shasta Dam may influence survival of anadromous salmonids eggs.

Redd site selection by anadromous salmonids depends on depth, velocity, and substrate of the microsite. However, intragravel (hyporheic) conditions have recently been more heavily implicated in redd site selection (Vyverberg et al., 1997; Geist and Dauble, 1998; Geist, in press). Chapman (1988) suggested that egg survival may be reduced at low water velocities. Direction (Geist and Dauble, 1998) and magnitude (Vaux, 1962) of water flow in redds changes with discharge fluctuation. We hypothesize that anadromous salmonids choose redd locations in particular hyporheic microsites because such positions provide a selective advantage, i.e. increased egg survival. There is a great deal of uncertainty in the importance of the hyporheic zone to anadromous salmonid egg survival. Abiotic and biotic parameters in this zone may determine egg survival.

Recovery of fall-run chinook and the federally listed spring-run chinook salmon requires successful reproduction of these fishes. Furthermore, the more escapement from tributaries such as Deer Creek the more quickly these fish populations can be strengthened. In this proposal, we define research to determine how dam releases could influence salmonid spawning success via the hyporheic zone. We plan to conduct laboratory experiments with hatchery-produced eggs of fall-run chinook salmon and spring-run chinook salmon. If due to permitting restrictions we are confined to fall chinook or steelhead eggs, we will continuously evaluate our ability to generalize to other fishes through surrogate egg sources.

The objectives of this study are to determine if discharge or fine sediment influences hyporheic flow direction or magnitude, hyporheic flow direction and magnitude influence anadromous salmonid egg survival in redds, Sacramento River hyporheic temperatures provide higher early arrival fall chinook egg survival than Deer Creek hyporheic temperatures, and finally determine if the Sacramento River's lower fine sediment loads provide higher early arrival fall chinook egg survival than Deer Creek's higher fine sediment loads.

CONCEPTUAL MODEL

A female salmon selects a redd position based upon a subset of the suite of characters that includes substrate, current velocity, streambed shape, depth, hyporheic flow, and cover. Temperature also could be a factor, a female may choose proximity to a spring or upwelling groundwater that produces a different thermal environment than the lotic surface water. After redd site selection takes place, she excavates a pit in the hyporheic zone, spawns with the male, and covers the spawned eggs with gravel from upstream. This process is reiterated until spawning is complete, the egg pocket is covered, a sinusoidal bed shape is produced (depression, covered egg pit, tailspill (see Bjornn and Reiser, 1991: p. 93)), and the female begins guarding the redd. She expires within a few days.

The hyporheic conditions, in which the eggs develop, have been heavily influenced by the female. By her selection of the redd site, she has chosen the range of macro- and microhabitat conditions the eggs will experience. By digging the pit, she has removed fine sediment from the egg placement area. The ultimate effect of the female's dec'isions and actions is to produce a micro-environment that provides appropriate temperature, dissolved oxygen and water velocity across the eggs. Appropriate temperature, dissolved oxygen and water velocity across the eggs may improve survival and therefore fitness. So, human manipulations of the system, dam operations, land use, etc., that alter these characteristics of the hyporheic in redds may directly influence fitness of anadromous salmonids.

The completion of Shasta (1944) and Keswick (1950) Dams and the Temperature Control Device (1996) resulted in many changes to the Sacramento River ecosystem. Here, we consider three of those changes on fall- and spring-run chinook salmon, *Oncorhynchus tshawytscha*, egg survival in redds: discharge regime, thermal regime, and fine sediment deposition.

Discharge regime in the Sacramento River has changed significantly with the operation of Shasta, a large mainstem dam, and Keswick, a re-regulation dam. Discharge influences hyporheic flow (Vaux, 1968). The hyporheic zone is the interface where surface water and groundwater components can both be found (Dahm and Valett, 1996). Surface water discharge influences hyporheic flow direction (Figure 1a and 1b). **And,** dissolved oxygen in the hyporheic varies with discharge (McNeil, 1962). Thus, changes in discharge regime influence flow and dissolved oxygen in the hyporheic zone; discharge then could influence salmonid egg survival by changing abiotic conditions in the hyporheic zone.

Discharge regime may also influence biotic conditions in the hyporheic zone (Nelson and Roline, 1999). Hyporheic biotic conditions that may be important to egg success include invertebrate composition and biomass. Invertebrates may limit survival by preying directly on both eggs and larval fish (e.g., Brown and Diamond, 1984; Elliott et al., 1997). Operation of dams and the temperature control device (TCD) allow manipulation of discharge and in the Sacramento River, temperature. Such manipulations of discharge and,temperature could change the invertebrate biomass and taxonomic diversity (e.g., Dole-Olivier et al., 1997) influencing salmon survival in redds.

Temperature can alter biotic conditions in the hyporheic and temperature can directly cause mortality to anadromous salmonid eggs (Brett, 1952; US Fish and Wildlife Service, 1998). We suggest that eggs of early-arriving fall chinook in Deer Creek may experience higher mortality due to high temperature (Figure 2) than eggs of early-arriving fall chinook in the mainstem of the Sacramento River. We define early-arriving fall chinook as those fall-run spawning between October 1 and 15.

Fine sediment in redds can reduce survival (Chapman, 1988; Kondolf, 2000, p. 268) in anadromous salmonid eggs. We hypothesize that Shasta Reservoir acts as a sediment trap in the Sacramento River and fine sediment load will be greater in tributary streams than the mainstem of the Sacramento River.

HYPOTHESES

H_1 = Hyporheic flow direction and magnitude differ with different discharge regimes and fine sediment load.

H_2 = Hyporheic flow direction and magnitude influence salmonid egg survival.

H_3 = Sacramento River hyporheic temperatures produce higher egg survival than Deer Creek temperatures in early-arriving fall chinook redds. Early arriving fall chinook are defined as those fall-run spawning between October 1 and October 15.

H_4 = Sacramento River fine sediment deposition is lower in anadromous salmonid redds and produces higher egg survival than fine sediment loads in Deer Creek redds.

There are several sets of data needed to distinguish between hypotheses. A data set which provides simultaneous observations of discharge (Q), hyporheic direction (vertical head gradient (VHG)), and hyporheic water velocity at a range of discharges will show discharge's influence on hyporheic flow. And, because reservoirs upstream of a spawning reach might influence hyporheic flow, data will be acquired in a set of streams that have a range of conditions from a large reservoir immediately upstream of spawning sites to no large reservoir. For this reason, and because we have funding partners, **we** have selected two streams reaches in California (Deer Creek, Sacramento R. - Keswick Dam To Red Bluff Diversion Dam) and two stream reaches in Washington (Cle Elum R., 1 km below Cle Elum Dam; Yakima R. at S. Cle Elum townsite).

The second data set needed requires observations of hyporheic flow direction and magnitude and associated egg survival. To collect sufficient observations for statistical analyses, we propose to collect these data in a laboratory model (Figure **3).** Furthermore, we intend to install egg-incubation tubes and piezometers at adjacent to redd sites in all four streams. This will allow field verification of controlled laboratory experimental results.

For the third and fourth hypotheses, we will install hyporheic pots (Nelson and Roline, 1999, p. 212) at redd sites in the Sacramento River and Deer Creek. With the pots installed in the hyporheic zone, the temperature, at 30.5 and 45.7 cm (12 and 18 inches) depth in the substrate, and fine sediments will be monitored. The thermal regime and fine sediment data will be used in the laboratory model to simulate the thermal and sediment conditions during redd development in the Sacramento River and Deer Creek. Eggs from the same female will be exposed to the two thermal and sediment regimes in the laboratory model and egg mortality observed through time.

ADAPTIVE MANAGEMENT

The justification for this project is simple, because salmonid eggs are laid in the hyporheic zone, an understanding of the abiotic and biotic components of that environment is essential to managing lotic ecosystems so that salmonids successfully reproduce. Regardless of substrate size and distribution, if temperatures or fine sediment loads **are** too high, eggs may not survive. If water flow across the eggs is insufficient waste products could accumulate in the egg pocket. Alternatively if fine sediment load is not too high, surface waters flowing into the substrate and entering a redd could deliver dissolved oxygen to the eggs. Or, upwelling waters could reduce fine sediment from settling on a redd. For several reasons hyporheic conditions could strongly influence anadromous salmonid egg survival. Thus, in the Sacramento River, where manipulation of discharge and temperature is possible we should understand the relationship between these discharge, temperature, hyporheic conditions, and egg survival.

It is not possible to manage hyporheic conditions without an understanding of how conditions in the hyporheic influence egg survival. Therefore, a pilot or implementation project could not be conducted because it is unknown what factors need remediation or management.

The experimental design is straightforward. First, we will determine the hyporheic conditions in fall- and spring-run chinook salmon redds. Second, we will conduct laboratory experiments using the field-determined conditions. Third, we will monitor egg survival in fall chinook salmon redds (sufficient eggs for spring-run field experiments may not be available according to the Feather River Salmon and Steelhead Hatchery) to determine if the laboratory results are indicative of the field situation. Experimental design can change in several ways to reflect data acquisition. The conditions in the field will in part determine the conditions in the laboratory experiment. Other independent variables may be identified as important or more important than discharge, temperature, and fine sediment load. For example, suppose hyporheic water chemistryshows a high concentration of a metal (see selenium (SE), Attachment A - Table 1), this might more strongly influence egg survival than fine sediment load (Figure **4)** in the redd. Then, field monitoring would elucidate such a relationship. Laboratory experiments could then be altered to anaiyze the relative importance of dissolved oxygen concentration and fine sediment load. Here, we have used dissolved oxygen **as** an example of other independent variables that field monitoring might bring to light. However, we intend to monitor other variables in the hyporheic zone such as pH, conductivity, and metal toxicity (see Attachment **A** - Table 2).

EDUCATIONAL OBJECTIVES

Our outreach program will educate landowners and the public in the northern Central Valley. Our educational objectives for this audience are three. First, we will demonstrate that the federal government and local landowner groups can work together to gain information for solving watershed management problems. Second, we will provide information to landowners and the public about how discharge and fine sediment may influence salmonid recovery efforts by methods that are not immediately obvious. Third, our work with this audience will show how research may be used to maintain water supplies, allow farming and other local uses to occur, work toward meeting CALFED's ERP goals, and manage the ecosystem to provide for increased anadromous salmonid reproductive success.

PROPOSED SCOPE OF WORK

Location

This project will be conducted in the mainstem of the upper Sacramento River (Shasta and Tehama Counties, Attachment L - Maps 1 and 2: Redding and Ukiah) and Deer Creek (Tehama County, Attachment L - Maps 2, 3, and 4: Ukiah, Chico, and Susanville). The ecozones included in the project are 3.1 - Sacramento River, Keswick Dam to Red Bluff Diversion Dam, 3.2 - Sacramento River, Red Bluff Diversion Dam to Chico Landing, and 7.4 - Butte Basin, Deer Creek.

The project's central point is approximately Red Bluff Diversion Dam (Tehama County). The geographic coordinates at this center point are approximately Latitude: 40°15'00" North and Longitude: 122°10'00" West.

Approach

For hypothesis 1 we intend to monitor discharge and simultaneously, hyporheic flow, in four experimental stream segments (two in CA, two in WA). We have used California Department of Water Resources, US Geological Survey (USGS), and US Bureau of Reclamation gauging stations to provide discharge data. All sites will have a gauge upstream without a major tributary entering between the gauge and study site. To determine hyporheic flow direction, we developed a piezometer (Figure 5) from hollow steel pipe with perforations (length of perforated section = 4") just above a custom-machined drive point. The piezometer is driven 18" and the perforations are then 14" to 18" deep in the hyporheic. After the water level in the piezometer equilibrates, the differential between the water level in the piezometer and the surface water is determined. Then, the vertical head gradient (VHG) is calculated as the quotient of water level differential and drive distance.

A series of piezometers ($n=30$) is laid down systematically through the spawning reach to monitor hyporheic flow availability (Figure la). A piezometer is installed immediately upstream of each redd (Figure Ib) and immediately downstream of the redd's tailspill. These two piezometers indicate the hyporheic flow direction and the hyporheic **flux** across the redd.

To evaluate hypothesis 2, we will install egg incubation tubes and hyporheic pots immediately adjacent to redds in Deer Creek and the upper Sacramento River. The incubation tubes allow us to determine egg survival in the hyporheic zone immediately adjacent to the redd. In addition, the hyporheic pots allow us to monitor the abiotic components of the hyporheic zone adjacent to the redd; we will use temperature and fine sediment load data to define hyporheic conditions we will simulate in the hyporheic model (Figure **3).** The hyporheic pots allow us to determine biotic conditions in the redd including invertebrate composition and biomass. After emergence is complete we will take a sediment sample from the redds to determine the sediment size frequency distribution (e.g. Figure **4).**

Hypotheses 3 and **4** will be evaluated with the use of a physical model that will be constructed at Reclamation's Water Resources Research Laboratory in Denver, Colorado. The physical model will be a sectional representation of the geomorphic conditions at redd sites found on the Sacramento River mainstem and Deer Creek. Redd substrate distribution will be acquired from field measurements (e.g. Figure **4)** and matched in the laboratory model. An objective of the physical model is to determine the relationship between surface, groundwater, and hyporheic flow characteristics. To achieve this objective, the physical model will have the capability of independently varying both surface and groundwater flow features to simulate wide ranging hyporheic **flow** conditions. A close coupling between laboratory and field measurements will be required to ensure adequate laboratory simulation of the physical phenomena encountered in the field. Thus, measurement techniques will be developed for field use to acquire data for comparison with the laboratory-developed relationship between surface, groundwater, and hyporheic flow characteristics. Figure **3** represents a plan and elevation view of the proposed physical model. The second objective of the model is to manipulate hyporheic flow characteristics in the laboratory to evaluate the influence of flow conditions on egg survival. Furthermore, we will construct the model so that we may control temperature and fine sediment. Thus, we may independently control hyporheic flow, temperature, and fine sediment to evaluate the effects of each on anadromous salmonid egg survival.

Monitoring and Assessment Plans

This research will allow us to determine abiotic and biotic parameters in the hyporheic zone. In addition, we will be able to monitor anadromous salmonid egg survival through egg incubation tubes and laboratory studies. Regardless of the outcome of the laboratory work, we will be able to describe the hyporheic zone in the vicinity of fall- and spring-run chinook salmon redds. Spring-run chinook redd monitoring will take place with the support of the US Forest Service (Attachment I). This description of the hyporheic will provide invaluable management information.

Data Handling and Storage

The data will be written originally on all weather paper. Immediately upon returning from the field the original field data are copied. A copy is retained by two of the investigators. Then transferred by technician to spreadsheet format (Excel 2000). A second technician then checks the data. The checked data are then saved to hard drives and diskettes in Red Bluff, CA and Denver, CO. During and at the end of the project hard copies of the data will be made available to California Department of Fish and Game and deposited in the National Archives. In addition, the data will be published in reports and literature publications.

Checked data will be analyzed via the Statistical Analysis System (SAS Inc., Cary, NC). Planned comparisons include the relationship between discharge and hyporheic flow and hyporheic flow and egg survival. These relationships will be approached statistically by analysis of variance (ANOVA). ANOVA requires that the data meet three assumptions: independence of observations, homogeneity of variance, and that the data be normally distributed. We obviously meet the assumption of independence of observations with our observations in four study streams. However, when we make observations of hyporheic flow at two discharges in the same stream there is some correlation between the different piezometers; they are all in the same physical space and thus are subject to the same meteorological and geomorphic features. Only one method would gain **us** completely independent observations of discharge and hyporheic flow; place only one piezometer in each study stream and increase the number of study streams to 30. We consider this approach cost prohibitive. We intend therefore to study autocomelation in the data before subjecting them to ANOVA. Our plots of the pilot data suggest that the data meet homogeneity of variance and normal distribution assumptions.

Expected Products/Outcomes

It is expected that several peer-reviewed publications will result from this study. Papers on field results of egg survival and insect communities associated with salmon redds along with separate papers on laboratory studies would be expected as various components of the study are. completed. After completion of all study aspects, a paper that would synthesize all of the different parts of the project would be produced. All results would be included in a final report to CALFED and California Department of Fish and Game. Results of the study would be presented at American Fisheries Society and North American Benthological Society meetings.

Work Schedule - See Attachment C

Feasibility

The described approach has had several components implemented in full scale at sites in Washington and Colorado. Independent variables such as hyporheic flow have been measured (by MBowen) systematically throughout spawning reaches and fall chinook redds in Sand Hollow Creek (Grant County) WA and Red Rock Coulee (Grant County) WA. Forty piezometers and six redds in each spawning reach have been measured immediately post-spawning. Two annual reports are available and a final report will be available September 30,2000. Hyporheic flow has been measured systematically throughout spawning reaches and spring-run chinook redds in the Yakima River (Kittitas County) WA and Cle Elum River (Kittitas County) WA. Some of these data are presented in Figure 1a and Ib. These data show that as discharge increased an increase in upwelling in the six redds occurred in the spawning reach of the Cle Elum River. This same effect was noted in the Deer Creek fall chinook redd in our pilot study. In the Deer Creek redd, the hyporheic was downwelling the day after spawning (11-12-99) but at a higher discharge on March 21,2000, the hyporheic was upwelling in the redd. In the Cle Elum River, the entire spawning reach also demonstrated an increase in upwelling. It is not known if this effect occurred in Deer Creek; thirty availability piezometers were not placed throughout the spawning reach because it was cost-prohibitive for the pilot study.

In addition to hyporheic flow, water chemistry will be monitored; hyporheic pots have been installed and monitored at three sites in the upper Arkansas River, (Lake County) CO (Nelson and Roline, 1999). Downstream of a contaminated site, these hyporheic pots showed zinc concentrations to be sufficient to kill salmonid eggs 18" deep in the hyporheic while surface waters showed insufficient zinc concentrations to kill salmonid eggs.

Materials used during our pilot redd on Deer Creek included egg incubation tubes, piezometers, and hyporheic pots. Sampled parameters included water chemistry, toxicity, redd sediments, fry emergence, and the invertebrate community. Despite problems with high flows, a complete set of parameters was collected and methods were tested.

Scientific collecting permits have been obtained for the salmon redd study by both Mark Bowen and S. Mark Nelson and have an expiration date of 10/20/01. The Coleman National Fish Hatchery provided eggs for the pilot project and will provide eggs for additional studies. The Feather River Salmon and Steelhead Hatchery (Oroville) has verbally committed to provide a limited number of spring-run chinook eggs if we meet permit requirements. Logistic field support has been provided by the Bureau of Reclamation facility in Red Bluff and it is expected that this relationship will continue. Permission to work on private lands has been obtained from members of the Deer Creek Watershed Conservancy (Attachment J). The specific spawning sites in the Sacramento River have not been identified but a spawning reach between Keswick Dam and Red Bluff Diversion Dam will be accessible by mask and snorkel or SCUBA.

Physical models are used for a wide variety of applications to simulate, describe, and further understand the physical characteristics of complex phenomena that are otherwise precluded from study using analytical techniques. Furthermore, in many cases such investigations prove cumbersome on a field scale where limited control is available for the variables that affect the critical processes. Laboratory models afford the systematic study of such phenomena in a controlled environment.

The approach to studying hyporheic flow phenomena in the laboratory is not new. Other scientists (Packman and Bencala, 2000) indicate that investigations of the near-surface exchange between surfaceflow and ground water flow using a recirculating flume, have been successfully conducted. Non-recirculating flumes have also been used to study such interactions, however difficulty arises in controlling critical water quality parameters. The recirculating physical model study proposed here, represents an extension of previous work to include variability of water quality parameters in a detailed study of direct impact on spawning redds. Furthermore, this approach provides the opportunity for development of new field monitoring techniques that will help ensure the success of field studies.

Feasibility for project completion is high because of Reclamation's Water Resources Research Laboratory physical modeling experience. Although not all processes can be investigated in the laboratory, many of them can. However, the critical link is the comparison of laboratory results with field results. This will provide baseline operational criteria to ensure that the critical physical processes are being modeled correctly. On the other hand, such laboratory investigations allow for improved interpretation of field data. For the past several years

Reclamation has developed a strong fisheries-engineering program that will certainly benefit this project and futures studies of this type.

APPLICABILITY TO CALFED ERP GOALS

ERP Goals

At-Risk Species. This research is aimed at scientific uncertainties regarding at-risk species: spring-run chinook salmon, and will be applicable to all runs of chinook salmon, and steelhead. We will monitor spring-run chinook redds in upper Deer Creek and fall-run chinook redds in the upper Sacramento River and lower Deer Creek. In addition, we will conduct laboratory experiments with hatchery provided fall-, and spring-run chinook eggs. Laboratory experiments with fall- and spring-run chinook eggs are dependent upon acquiring permits. However, all these experiments and this research is aimed at two general principles for which there is great scientific uncertainty: What is the relationship, if any, between discharge of surface waters and hyporheic flow and direction? What is the relationship, if any, between hyporheic flow and direction and anadromous salmonid egg survival? The intention of this study is to obtain data that will make it possible to maintain water supplies and manage discharge regime at dams to improve chinook salmon egg survival in redds. Similarly, in the upper Sacramento River, we may control temperature to some extent with the TCD. The intention of this study is to obtain data that will make it possible to manage temperature regime at Shasta Dam to improve chinook salmon egg survival in redds. Furthermore, we will evaluate temperature in the hyporheic immediately adjacent to spring chinook redds in upper Deer Creek and determine if temperature may be influencing survival of early life stages. In addition, we will evaluate the influence of fine sediment load on the survival of fall- and spring-run chinook in Deer Creek. All of these components will make it possible for **us** to consider the influence of discharge, temperature, and fine sediment on the hyporheic zone and spring-run chinook salmon in the upper Sacramento River watershed.

Ecosystem Processes and Biotic Communities. Abiotic ecosystem processes including the hydrologic cycle provide the environmental template upon which biotic communities are based. The pathways of water overland and subsurface to stream waters can provide groundwater that is high in dissolved nutrients and low in dissolved oxygen. Downwelling surface waters into the hyporheic zone can provide oxygen. Water moves into gravel and upwells downstream depending on channel shape. All these hydrodynamic processes interact with other abiotic processes in the hyporheic zone to produce a complex mosaic in which microbial and invertebrate food webs operate. In turn, abiotic and biotic processes produce varying invertebrate diversity and biomass that changes longitudinally and laterally in the hyporheic zone. Anadromous salmonids dig a redd and deposit their eggs into this zone that is influenced by discharge, gradient, streambed shape, microbes, the invertebrate community, and other factors. Yet, we know very little about how to maintain the natural functioning of these systems. It seems possible that maintenance of self-sustaining biotic communities may be maintained in this habitat without human intervention; however, we have little information to support this. Our hyporheic pots in the intragravel will allow us to gather such information. Furthermore, we have almost no information about how to manage these systems in a manner that would favor native organisms. This research is designed to allow us to understand some basic relationships at work in the hyporheic zone where anadromous salmonids deposit their eggs, eggs develop, and alevins survive.

Habitats. This research will provide data concerning three habitats under the classification system of Moyle and Ellison (1991): A2431 - Spring chinook stream, A2441 - Valley floor river, and A2442 - Fall chinook salmon spawning stream. However more specifically, this research provides basic information about a habitat type critical to successful reproduction of anadromous salmonids: the hyporheic zone. If we wish to protect the essential nature of this habitat, manage it to provide incubation habitat for salmon and steelhead, we must understand the processes that influence it and maintain it. Furthermore, this research is aimed at understanding those processes and biotic components that are aimed at recovering listed anadromous salmonids.

Relationship to Other Ecosystem Restoration Projects

Research addressing uncertainties related to flow regime has been a focus of CALFED funding. Project 99-B166 - "Focused Action to Develop Ecologically-based Hydrologic Models and Water Management Strategies in the San Joaquin Basin" will collect information regarding channel dynamics and sedimentation. The research described here provides similar information in the Sacramento River, and one of its tributaries, on flow regime and sedimentation and the effects of these factors on anadromous salmonid egg survival.

Management planning may be improved by an understanding of intragravel conditions. Projects such as 99-B126 "Subreach/Site-Specific Management Planning on the Sacramento River" could use information on discharge and the hyporheic to improve their management of hydrologic conditions providing for improved anadromous salmonid egg survival. The "Panoche/Silver Creek Watershed Management and Action Plan," 99-C105, has an objective to reduce sediment. The study proposed here would provide data on what level of sedimentation can be survived by certain at-risk species.

Restoration projects in areas that influence groundwater flow may significantly impact hyporheic conditions. The "Last Chance Creek Watershed Restoration" Project, 99-C100, will. restore 9.1 miles of channel and 4,330 acres of meadow. This restoration project may make major improvements in hyporheic conditions or it may fail because relationships between groundwater flow patterns, discharge, and the hyporheic are poorly understood. Other restoration projects such as 98-C1024 "Lower Clear Creek Ecosystem Restoration Project" could have gained considerably in their effort to improve habitat conditions for native fish if the necessary components of the intragravel that provide for successful spawning were more clearly defined.

Projects such as 98-C1033 "Deer and Mill Creeks Acquisition and Enhancement" might be enhanced if critical areas of spawning and hyporheic and groundwater interconnections were better understood. For example, parcels of land that have interrupted connections between surface and sub-surface water could be purchased. Flow between sub-surface and surface waters could be reconnected and anadromous salmonid reproductive success could then be enhanced.

System-wide Ecosystem Benefits

The hyporheic zone is the location of all anadromous salmonid egg deposition. The hyporheic provides dissolved oxygen, temperature, and a water quality environment necessary for the survival of salmonid eggs and alevins. Yet, managers poorly understand this zone, its effects on early life stage survival, and how it may be managed.

The targeted research we outline here, will provide basic information on this area of great uncertainty. If the hyporheic zone is essential to the successful rearing of early life stages, a lack of understanding may subvert recovery in the entire ecosystem. We propose to conduct this research so management of the hyporheic zone via discharge and temperature manipulations may provide adequate rearing conditions for chinook salmon and steelhead reproduction throughout the Central Valley.

QUALIFICATIONS

Mark D. Bowen. A Fishery Biologist with Reclamation, he received his doctorate from Utah State University in Aquatic Ecology in 1996. His dissertation: "Habitat selection and movement of a stream-resident salmonid in a regulated river and tests of four bioenergetic optimization models" focused on rainbow trout, *Oncorhynchus mykiss*. In this study he showed that habitat selection was consistent with bioenergetic optimization by larger fish. In addition, a relationship between discharge, habitat selection, and fish movement was demonstrated. Recently, Mark Bowen is conducting redd surveys in two watersheds on the Columbia Basin Project (WA). This on-going project will last three years, a final report is due September 30, 2000. In 1998, he found a relationship between hyporheic flow direction and magnitude and the likelihood that a fall chinook female would choose to spawn in a particular location. See Table D-1 for reports published in California.

Ray Bark. Biological science trainee with the Reclamation who is completing a master's degree in Environmental Management at the University of Denver (June 2000). Degree major emphasis is natural resource and watershed management. His relevant experience: Evaluation of Lake Shasta's temperature control device (in progress). Investigations of fish friendly **pumps** (Red Bluff and Tracy, CA), fish passage and entrainment-reduction techniques, and water quality.

Sandy Borthwick. Supervisory Fisheries Biologist, US Bureau of Reclamation, Education include B.S.- Utah State University, M.S.- Colorado State University - Wildlife and Fisheries Biology. Sandy Borthwick has been with Reclamation since 1994, conducting fisheries research at Red Bluff Research Pumping Plant in Red Bluff, California. Biologist with the National Park Service (NPS) from 1989 - 1994. Prior to that, held temporary biologist positions with U. S. Fish and Wildlife Service and Bureau of Land Management. See Table D-2 for publications.

Walt Duffy. Director, California Fish and Wildlife Research Unit, Humboldt State University, Arcata, CA. Please see Attachment E for Dr. Duffy's curriculum vitae.

Joe Kubitschek. Hydraulic Engineer, US Bureau of Reclamation. Please see Attachment E for Joe Kubitschek's résumé.

S. Mark Nelson. Research Aquatic Scientist, US Bureau of Reclamation. Please see Attachment E for Mark Nelson's short résumé.

COST

Budget

In the budget DCWC billable rate is $22 per hour. we identify three levels of salaried investigators and administrators with Reclamation. Reclamation includes all costs, salary, benefits, and indirect costs in the billable rate specified in this paragraph. In the attached budget tables (Attachment F), we have split our billable rate into three costs according to the format provided by CALFED: salary, benefits, and overhead. The levels specified in the budget tables are: USBR Level 1, Technician, includes co-principal investigator Ray Bark and bills at $59 per hour. USBR Level 2, Professional biologist and engineer, includes principal investigator Mark Bowen and co-principal investigators Sandy Borthwick, Joe Kubitschek, and Mark Nelson and bills at $75 per hour. USBR Level 3, Management series, includes Reclamation-Denver's Fisheries Applications Research Group Manager, Diana Weigmann and bills at $89 per hour. The graduate student identified in the budget tables is specified "Grad. St." and bills at the rate specified in the table according to costs at Humboldt State University.

Project Management

The costs for project management are included in the hours specified for Reclamation's Level 2 and Level *3* in the budget. The specific activities requiring these costs are evaluation of field work, laboratory methods and procedures, and review of deliverables. In addition, validation of spending, managing personnel, and other project oversight is included in these values.

The costs for project management by the DCWC are included in the In Kind Services provided by DCWC and Sierra Pacific Industries. These management activities will include oversight of the outreach program, observing field work, and reviewing deliverables.

Cost Sharing

One of the entities in this joint-venture research (Deer Creek Watershed Conservancy, DCWC) will provide In Kind Services (IKS) toward this project. The DCWC will provide time for James Gaumer to assist in field research, review, and edit all reports. The cost provided to the project by these IKS is $9,000 over the duration of the project.

Sierra Pacific Industries will provide In Kind Services (IKS) toward this project. Sierra Pacific Industries will provide time for Julie Kelley to assist in field research, review, and edit all reports. The cost provided to the project by these IKS is $9,050 over the duration of the project.

Reclamation's Upper Columbia Area Office (UCAO-Yakima, WA) will provide $25,000 / yr. for model construction and experiments for **3** years. Denver's Research and Technology Transfer office will provide $35,000/ yr. in funding for field work. In total, $198,150 in matching funds are available for use on this project in California's Central Valley.

The research we have described here is paired with a study in Reclamation's UCAO area. The two sites and the two sites selected in California lie on a continuum from large reservoirs immediately upstream of the spawning site to no large reservoir on the stream. Because discharge regulation and reservoirs may change hyporheic conditions, this study is designed to study the relationship between discharge, abiotic and biotic parameters in the hyporheic, and anadromous salmonid egg survival in a range of ecosystems. For example, Deer Creek has no large dams: the Cle Elum River study site lies within one km of a dam that impounds a reservoir of over 150,000 surface hectares (Cle Elum Reservoir). The upper Sacramento River and the Yakima River (S. Cle Elum town-site reach) are intermediate between Deer Creek, CA and the Cle Elum River, WA. However, all four sites support populations of chinook salmon that spawn in October. Therefore, the information collected in Washington is an extremely useful component to understanding the role of discharge regulation and reservoirs on hyporheic conditions and anadromous salmonid early life stage survival. The information being collected in Washington is by funding independent of this proposal. However, the opportunity exits to combine study sites and provide a more general understanding of the relationships between reservoirs, discharge regulation, hyporheic conditions, and anadromous salmonid egg survival. This opportunity will provide more general information useful throughout the Central Valley of California.

LOCAL INVOLVEMENT

We have notified two local government's Board of Supervisors, Shasta and Tehama Counties (see Attachment H). We intend to follow written notification with phone calls to answer any questions concerning the proposal and listen and respond to any concerns of local governments.

The DCWC will execute a public outreach program including a newsletter to all landowners and stakeholders (includes environmental groups, agencies, interested organizations, etc.), personal contact with landowners, and open public meetings annually. The executive director, Dianne Gaumer, will attend CALFED watershed workgroup meetings and provide information to the Education/Outreach Director, Joan Hemsted, to be included in all public outreach. The DCWC is a joint partner and this research meets goals specified in the Deer Creek Watershed Management Plan (Deer Creek Watershed Conservancy, 1998) and many local landowners are members of the DCWC. Several members and local landowners have provided verbal permission to work on their property. One landowner that gave us permission to access Deer Creek via his property was Fred Hamilton ((530)839-2819). During our pilot work, we notified Mr. Hamilton every time we were working in the vicinity. He always consented to our access to Deer Creek via his property. Other landowners that gave us verbal permission were Pete Wells ((530)839-2445), Robbie Robertson (now deceased), and The Abbey of New Clairvaux ((530)839-2161). These landowners and many others are aware of the proposed project and are generally supportive.

To our knowledge, there will be no third party impacts.

COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

We have studied the CALFED PSP table D-1, read the Additional Clauses and Contracts With the United States forms, and agree to comply by these and all other state and federal standard terms.

ATTACHMENT A
TABLES

Table 1. Dissolved elements by ICP/ES (μg/L) in surface waters and at two depths in the hyporheic zone (12" and 18") immediately adjacent to a fall-run chinook salmon redd in lower Deer Creek (Tehama County, CA). Spawning took place on 11-11-99 and 11-12-99.

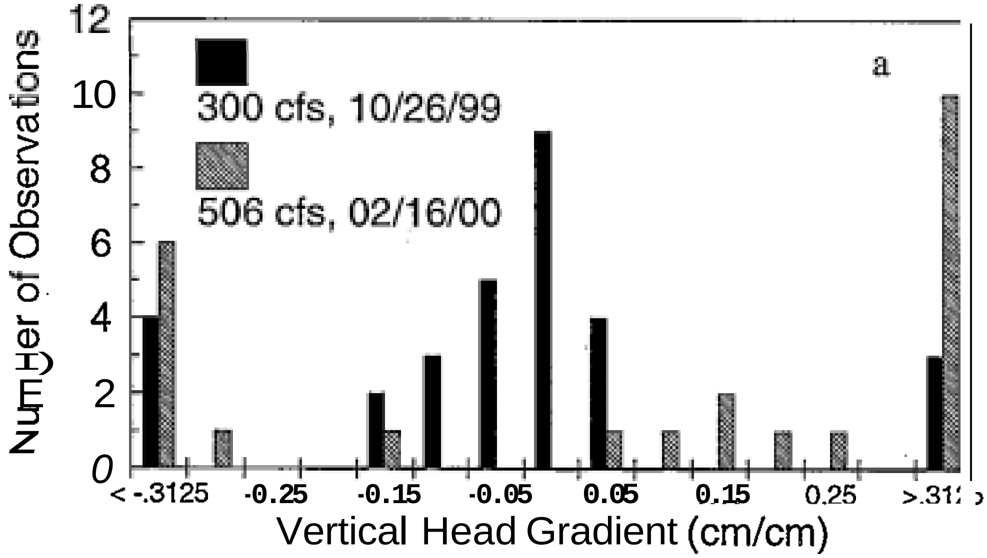
Element	December 14, 1999			March 21,2000		
	Surface	12"	18"	Surface	12"	18"
Ag	<4	<4	<4	<4	<4	<4
Al	<30	<30	<30	<30	<30	<30
As	<70	<70	<70	<70	<70	<70
B	123	123	123	39.4	34.4	43.3
Ba	12.9	12.8	12.1	7.44	7.25	9.85
Be	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cd	<4	<4	<4	<4	<4	<4
Co	<3	<3	<3	<3	<3	<3
Cr	<4	<4	<4	<4	<4	<4
Cu	<4	<4	<4	<4	<4	<4
Fe	18.9	15.4	12.0	16.0	7.44	33.3
Li	<6	<6	<6	<6	<6	<6
Mn	<4	<4	<4	<4	<4	32.1
Mo	<10	<10	<10	<10	<10	<10
Ni	<10	<10	<10	<10	<10	14.7
Pb	<30	<30	<30	<30	<30	<30
Sb	<20	<20	<20	<20	<20	<20
Se	<30	<30	<30	<30	<30	37.2
Sr	75.5	74.8	74.3	49.3	48.2	53.5
V	5.80	4.26	<4	<4	<4	6.61
Zn	<4	<4	<4	<4	<4	5.68

Table 2. Observations of water chemistry in surface waters and at two depths in the hyporheic zone (12" and 18") immediately adjacent to a fall-run chinook salmon redd in lower Deer Creek (Tehama County, CA). Spawning took place on 11-11-99 and 11-12-99.

Date	Level	Temp.	D.O.	pH	Conductivity
11-13-99	Surface	10.6	10.6	7.93	149
	12"	10.8	10.2	7.40	150
	18"	11.0	10.2	7.93	150
12-14-99	Surface	5.1	13.3	7.99	149
	12"	5.2	13.0	7.97	150
	18"	5.3	12.6	7.93	151
3-21-00	Surface	7.9	12.1	7.88	88
	12"	8.9	4.8	7.48	90
	18"	8.7	5.5	7.12	111

ATTACHMENT B
FIGURES

Figure 1. a) Hyporheic availability and b) hyporheic flow in spring chinook redds in *the* Cle Elum River, WA, USA.



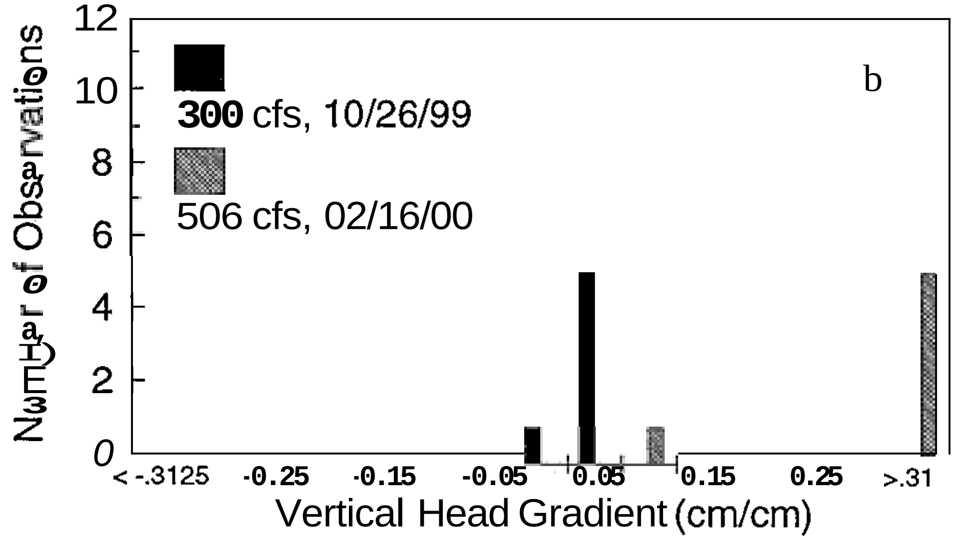
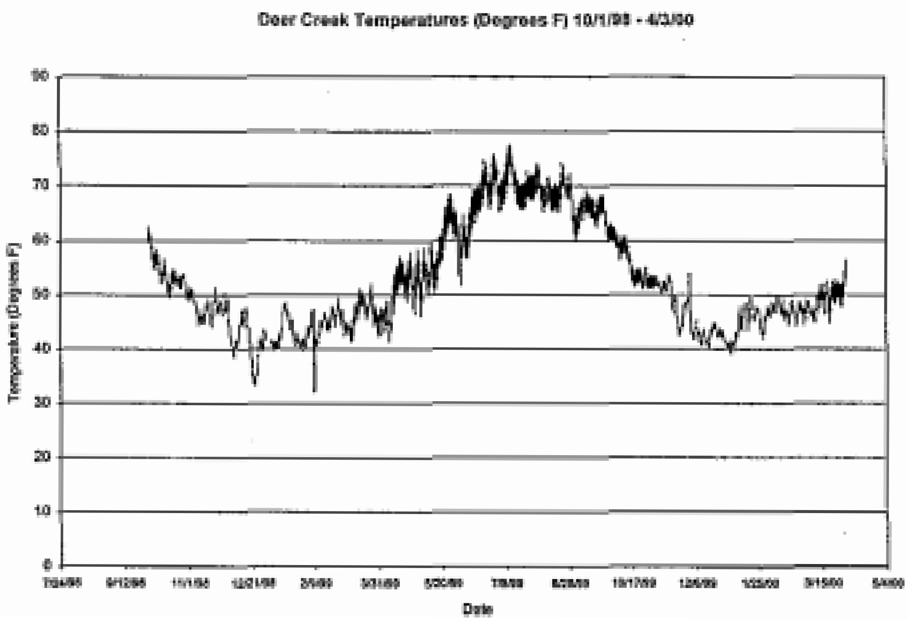


Figure 2. Surface water temperatures in Deer Creek and the upper Sacramento River, CA.



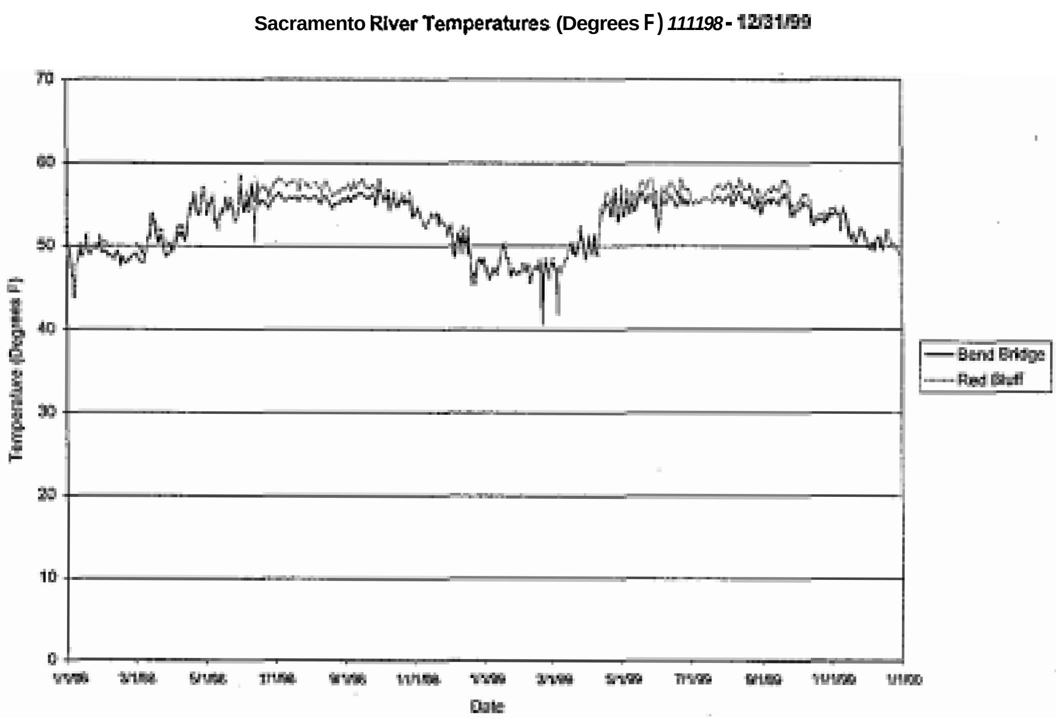


Figure 3. Schematic of proposed physical model.

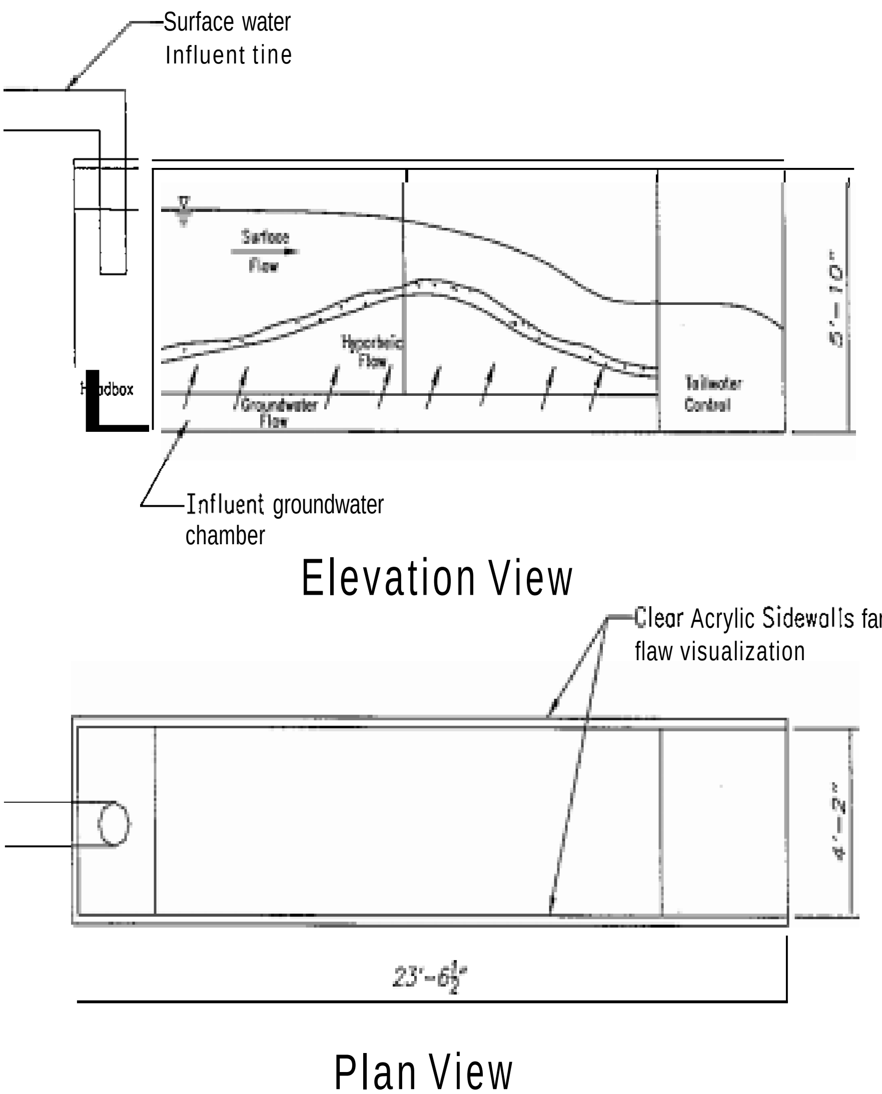


Figure 4. Sediment size distribution in a fall-run chinook salmon redd in lower Deer Creek (Tehama County, CA). Spawning took place on 11-11-99 and 11-12-99.

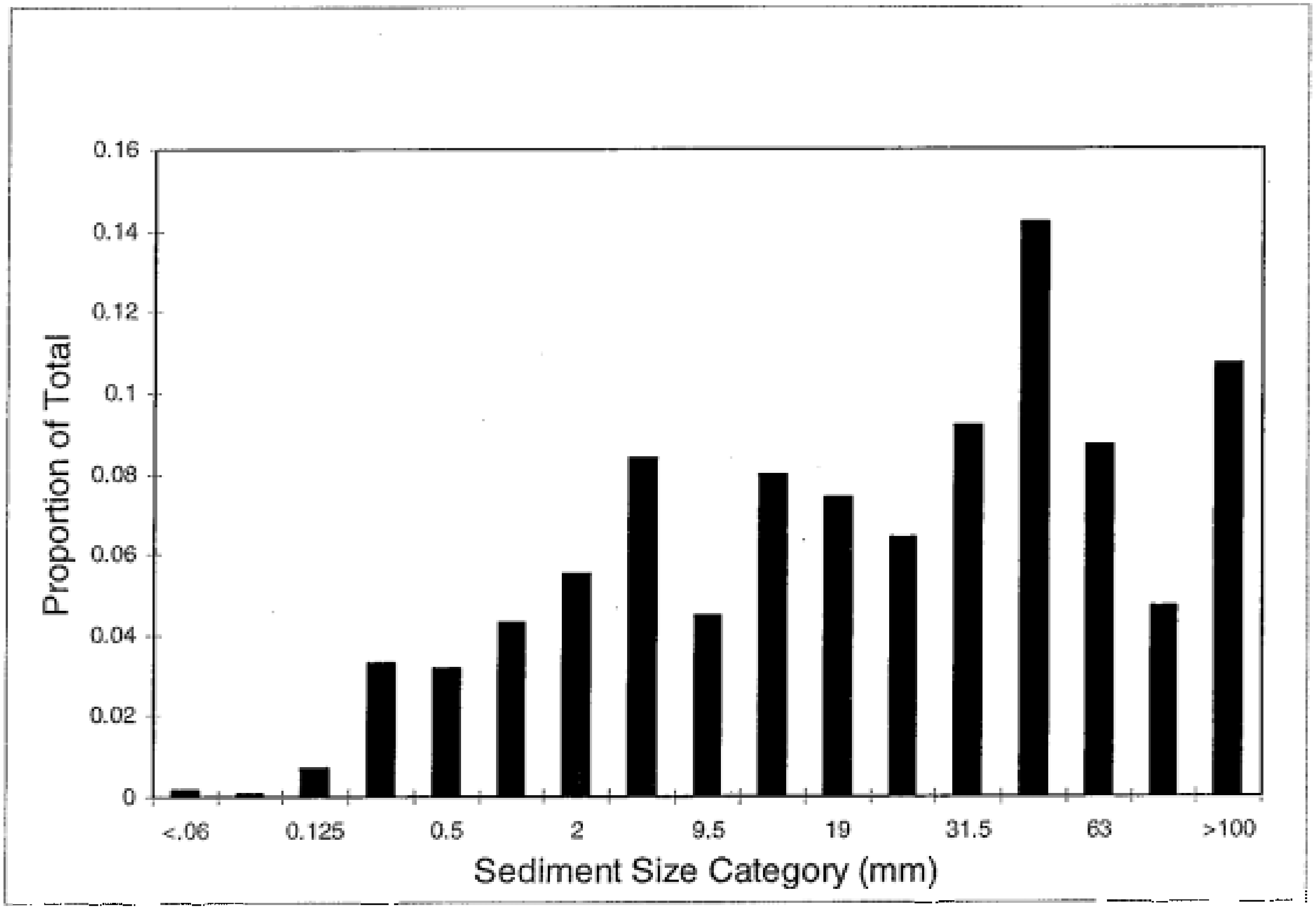
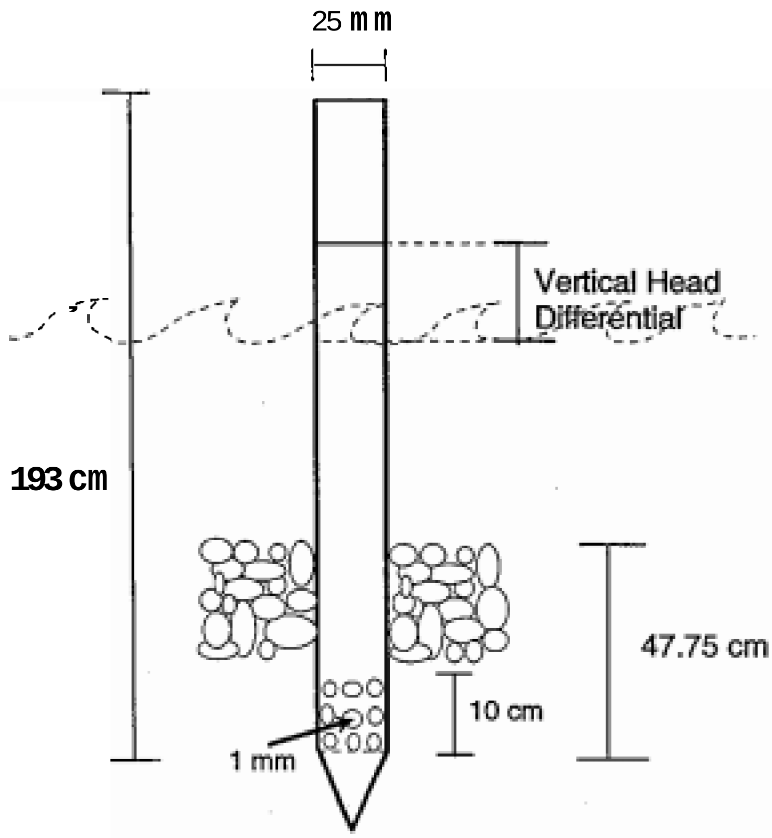


Figure 5. Cross section view of piezometer.



ATTACHMENT C
WORK SCHEDULE

TASKS	SCHEDULE
Acquire Field Data for Physical Model	Oct. 1, 2000 - Mar. 15, 2001
Model Construction	Oct. 1, 2000 - Nov 30, 2000
Model Instrumentation Setup	Dec. 1 - Dec. 8, 2000
Model Testing and Data Acquisition	Dec. 8 - Jan. 31, 2001
Evaluate and Fine Tune Model Performance	Feb. 1 - Oct. 1, 2001
In-situ Egg Survival Experiments in Model	Oct. 1, 2001 - Mar. 1, 2001
Map Anadromous Salmonid Redds	Oct. 1-15, 2001
Monitor Hyporheic, Redds + River Operations	Oct. 1, 2000-Mar. 31, 2002
Enter Data	Apr. 1-Apr. 30, 2002
Analyze Data	May 1-Jun 30, 2002
Submit Annual Report	Sep. 30, 2002
In-situ Egg Survival Experiments in Model	Oct. 1, 2002 - Mar. 1, 2002
Map Anadromous Salmonid Redds	Oct. 1-15, 2002
Monitor Hyporheic, Redds + River Operations	Oct. 1, 2002-Mar. 31, 2003
Enter Data	Mar. 1-Apr. 30, 2002
Analyze Data	May 1-Jun 30, 2002
Write Annual Report	Jul. 1-Sep 30, 2002
Map Anadromous Salmonid Redds	Oct. 1-15, 2002
Monitor Redds + River Operations	Oct. 1, 2002 - Feb. 29, 2003
Enter Data	Mar. 1-Apr. 30,2003
Analyze Data	**May** 1-Jun 30,2003
Write Annual **Report**	**Jul. 1-Sep** 30,2003
Submit Journal Articles	Jul. 1-Sep 30, 2003

ATTACHMENT D

QUALIFICATIONS TABLES

Table D-1. Publications of Mark Bowen involving California's San Francisco Bay-Delta Ecosystem. See Literature Cited for full reference.

Year	Co-authors	Title
1998	S.Siegfried, C.Liston, L.Hess, and C.Karp	Fish Collections and Secondary Louver Efficiency at the Tracy Fish Collection Facility: October 1993 to September 1995.
In Press	S. Siegfried, C. Liston, L. Hess, and C. Karp	Empirical and Experimental Analyses of Secondary Louver Efficiency at the Tracy Fish Collection Facility: March 1996 to November 1997.

Table D-2. Publications of Sandy Borthwick.

Cudlip, L., M. Malich, and S. Borthwick. 1994. Biomonitoring stream sites: the key to addressing biodiversity at Curecanti National Recreation Area? National Park Service Report.
Borthwick, **S.** M. 1990. Impacts of ethyl and methyl parathion on aquatic invertebrates inhabiting prairie wetlands. Unpubl. manuscript. 27pp.
Borthwick, S. M. 1991. Water quality of the Fremont River from the Bicknell Bottoms through Capitol Reef National Park. National Park Service Report. 50pp.
Borthwick, **S.** M., R. R. Corwin, and C. R. Liston. 1999. Investigations of fish entrainment by Archimedes and internal helical pumps **at** the Red Bluff Research Pumping Plant, Sacramento River, California: February 1997 - June 1998. Red Bluff Research Pumping Plant Report Series, Volume 7. U. S. Bureau of Reclamation, Denver, CO.
Grue, **C.** E., M. W. Tome, G. A. Swanson, **S.** M. Borthwick, and L. R. DeWeese. 1988. Agricultural chemicals and the quality of prairie-pothole wetlands for adult and juvenile waterfowl -- what are the concerns? Pages 55-64 in P. J. Stuber, coordinator. Proceedings of the National Symposium on the Protection of Wetlands from Agricultural Impacts. USDI Fish and Wildlife Service Biological Report 88(16). 221 pp.
McNabb, C. D., C. R. Liston, and S. M. Borthwick. 1998. In-plant biological evaluation of the Red Bluff Research Pumping Plant on the Sacramento River in Northern California: 1995 and 1996. Red Bluff Research Pumping Plant Report Series, Volume **3.** U. S. Bureau of Reclamation, Denver, CO.
Weber, E. D., and S. M. Borthwick. 2000. Plasma cortisol levels and behavioral stress responses of juvenile chinook salmon passed through Archimedes and internal helical pumps at Red Bluff Research Pumping Plant, Sacramento River, California. Red Bluff Research Pumping Plant Report Series Volume 8. U. S. Bureau of Reclamation, Red Bluff, CA.

ATTACHMENT E

CURRICULUM VITAE AND RÉSUMÉS

CURRICULUM VITAE

Walter G. Duffy
California Cooperative Fisheries Research Unit
Humboldt State University
Arcata. CA 95521
707-826-5644
wgd7001@axe.humboldt.edu

Education

B.S. 1973 Fisheries & Wildlife, Michigan State University, East Lansing
M.S. 1975 Fisheries & Wildlife, Michigan State University, East Lansing
Ph.D. 1985 Fisheries-Limnology, Michigan State University, East Lansing

Professional Employment

1997- Leader, California Cooperative Fisheries Research Unit, Humboldt State University, Arcata. CA
1988-97 Assistant Leader, South Dakota Cooperative Fish and Wildlife Research Unit. South Dakota State University, Brookings, SD.
1984-88 Ecologist, National Wetlands Research Center, U.S. Fish & Wildlife Service, Slidell. LA.
1981-84 Senior Research Assistant. Michigan State University, East Lansing, MI.
1978-81 Laboratory Director, Dunbar Research Station, Michigan State University. Barbeau, MI.
1977-78 Research Biologist, Ludington Great Lakes Lab., Michigan State University, Ludington, MI.
1975-76 Research Biologist, Ichthyological Associates Inc., Pottstown, PA.

Teaching Experience

1998- Fish Bioenergetics (developed and taught lecture and laboratory)
1994-96 Advanced Limnology (developed and taught lecture and laboratory)
1990-92 Limnology (developed and taught lecture and laboratory)
1990-96 Aquatic Invertebrate Ecology (developed and taught lecture and laboratory)
1984 General Entomology (taught lecture)
1984 General Ecology (taught lecture)

Awards

1998 STAR Award from Chief Biologist for Contributions to U.S. Geological Survey
1996 Awarded Promotion by Research Evaluation Panel, U.S. Geological Survey
1994 Co-Recipient, Chiefs Award for Outstanding Science, Division of Cooperative Research, NBS
1993. Certificate of Appreciation for Service, American Fisheries Society
1993 Promotion from Assistant to Associate Adjunct Professor, South Dakota State University
1992 Certificate of Appreciation for Service, American Fisheries Society
1992 Ten Year Service Recognition, National Biological Service
1991 Special Achievement Award, U.S. Fish and Wildlife Service
1988 Special Achievement Award, U.S. Fish and Wildlife Service
1986 Special Achievement Award, U.S. Fish and Wildlife Service

Journal Peer Reviewer

Canadian Journal of Fisheries and Aquatic Sciences
North American Journal of Fisheries Management
Transactions of the American Fisheries Society
Journal of Great Lakes Research
Ecology
Freshwater Biology
Regulated Rivers
Wetlands

Society Membership and Service

American Association for the advancement of Science
American Fisheries Society

- Local Program Chair for National Meeting (1990)
  Chaired NCD Reservoir Technical Committee (1992-93),
  NCD Newsletter Editor (1989-90),
  Member of Committees for: Meeting Raffle (1996-98) Publications Overview (1995-97). Canadian Concerns (1991-92) Continuing Education (1994-97).

Ecological Society of America
North American Benthological Society
Conservation Committee, 1992-94
Sigma Xi (SDSU Membership Committee, 1994)
Society of Wetland Scientists
Associate editor, 1998 -

Service

1998 - Chair, salmon and steelhead restoration panel, California Dept. of Fish and Game
1997 - Technical advisor, Forest Sciences Project, Humboldt State University, Arcata, CA
1995 Speaker and Panelist, Environmental Ethics, Brookings Middle School, Brookings, SD
1993-94 Advisor, River **Quest** Environmental Program, Central School, Brookings, SD
1992-93 Organizer and Participant, Brookings Water Festival, Brookings, SD
1990-91 Board of Directors, Catholic Campus Parish, Brookings, SD
1989-92 Technical Advisor, Lake Poinsett Association, Hayti, **SD**
1985-87 Curriculum Committee, **St.** Margaret Mary School, Slidell. LA

Grants and Contracts Awarded

1999 Investigations of the Trophic Ecology of the Upper Sacramento River. **U.S.** Bureau ***of*** Reclamation ($45,000).

Design and Evaluation of a Downstream Migrant Fish Trap to Minimize Predation Mortality. National Marine Fisheries Service ($50,000)

Limnology of Napa-Sonoma Salt Ponds in the San Francisco Estuary. U.S. Geological Survey **($60,000)**

1999 Measuring Restoration of Pacific Watersheds: A Workshop. U.S. Geological Survey ($25,000)

The effect of habitat quality on survival of juvenile coho salmom. National Marine Fisheries Service, Tiburon, CA ($372,000).

Biological Assessment of Streams within the Kings Range National Recreation Area. **U.S.** Bureau of Land Management ($41,000).

1997 Biological assessment of streams impacted by gold mining activities in the Black Hills, SD. U.S. Fish and Wildlife Service, Pierre, SD.

1997 Entrainment of rainbow smelt by turbines of Oahe Reservoir. South Dakota Department of Game, Fish and Parks, Pierre, SD.

1997 Energy acquisition by shorebirds using temporary and seasonal wetlands. South Dakota Department of Game, Fish and Parks, Pierre, SD and Hudson Bay Project Corp., Stamford. CT.

1996 Influence of fathead minnows on nutrient partitioning, water clarity, and ecosystem structure in prairie wetlands. Institutes for Water Resources, U.S. Geological Survey, Lincoln, NE (with M. Butler and M. Hanson).

1996 Status and distribution of rare aquatic species in streams and wetlands of the north-central grasslands. U.S. Forest Service, Chadrin, NE.

1996 Interbasin transfer of fish. South Dakota Department of Game, Fish and Parks, Pierre, SD.

1995 Assessing Ecosystem Integrity: A modeling approach. National Biological Service, Wash, DC

1995 Design and performance of created wetlands. South Dakota Department of Transportation, Pierre, SD.

1994 Biodiversity of created, restored and natural wetlands **in** the northern Great Plains and Prairie Pothole Regions of South Dakota. U.S. Fish and Wildlife Service, Denver, CO.

1994 Influence of commercial harvest on population dynamics **of** fathead minnows in South Dakota marginal lakes and wetlands. South Dakota Department of Game, Fish and Parks, Pierre, SD

1993 Limnology of Shadehill Reservoir, South Dakota. South Dakota Department of Game, Fish and Parks, Pierre,

1992 Bioenergetics of chinook salmon and walleye in Lake Oahe, South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, SD

1989 Impact of agricultural chemicals on prairie wetlands. U.S. Fish and Wildlife Service, Bismarck, ND

1988 Limnology of Missouri River reservoirs. South Dakota Department of Game, Fish and Parks, Pierre, SD

1987 Trophic value of bottomland hardwood and agricultural wetlands to wintering female mallards in Louisiana. U.S. Fish and Wildlife Service, Slidell, LA

1984 Aquatic Invertebrates of Paint Creek, Michigan. Rochester Michigan Chapter, Trout Unlimited.

Peer Reviewed Publications

Larson, K.L. and W.G. Duffy. Stable carbon and nitrogen isotopes as indicators of trophic dynamics in created, restored and natural prairie wetlands. In *prep.*

Butler, M.G., K.D. Zimmer, M.A. Hanson and W.G. Duffy. Influence of fathead minnows on nutrient cycling, nutrient partitioning and ecosystem structure in prairie wetlands. Submitted *to Canadian* Journal *of Fisheries* and *Aquatic Sciences*

Larson, K.L. and W.G. Duffy. Habitat features associated with bird, amphibian and fish community diversity in created, restored and natural prairie wetlands. Wetlands In *press.*

Railsback, S.F., R.H. Lamberson, B.C. Harvey and W.G. Duffy. Movement rules for spatially explicit individual-based stream fish models. Ecological Modeling In *Press.*

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EDUCATION

Ph.D. Candidate, Mechanical Engineering, Fluid Mechanics, University of Colorado.
M.S., Mechanical Engineering, University of Colorado, 1999.
B.S., Mechanical Engineering, University of Colorado, 1990.

CURRENT POSITION:

Hydraulic Engineer, U.S. Bureau **of** Reclamation - Water Resources Research Laboratory, D-8560, P.O. Box 25007, Denver, CO 80225-0007.

RESEARCH EXPERIENCE:

Hydraulic Engineer, U.S. Bureau **of** Reclamation, 1991-Present: Provide technical expertise in the field of hydraulic research and development with emphasis on environmental hydraulics, hydraulic structures. hydraulic equipment, and applied fluid mechanics.

- Principle Investigator for **the** Hungry Horse Selective Withdrawal System physical model study and laboratory development, 1-yr, $120K.
- Principle Investigator for the 'Red Bluff Diversion Dam Fish Passage physical model studies designed to improve the understanding of tailrace attraction flow velocity fields and subsequently identify methods for enhancing fish passage performance, 2-yr, $80K.
- Co-Principle Investigator for the Red Bluff Diversion Dam hydraulic field evaluation of the existing right abutment fish ladder, 6-mo, $45K.
- Principle Investigator for the Grand Valley Irrigation District Fish Passage physical model study to identify viable alternatives for providing passage of endangered native species resident in the Colorado River, 1-yr, $50K.
- Principle Investigator for the Tracy Fish Facilities Improvement Program laboratory investigations focusing on improving existing louver technology and subsequent fish salvage efficiency, 5-yr, $150K/yr.
- Principle Investigator **for** the Fish Screen Research Program designed to develop advanced screen technology for small diversions, 3-yr, $70K/yr.
- Project Engineer for the Glen-Colusa Irrigation District Fish Screen physical model studies designed to develop and optimize concept performance consistent with resource agency criteria.
- Principle Investigator for the Hydrodynamic Stability Research Project initiated to study the mechanics, stability, and break-up of free-fluid jets discharged into air, under the influence of gravity (Ph.D. Thesis Topic).

Mechanical Engineering Intern II, Ball Aerospace Technologies **Corp.,** 1990-1991: Design and laboratory development of functional mechanical mechanism and space flight hardware.

- Developed laboratory operational procedures and conducted testing of developmental space flight hardware: **A** long life regenerative cryo-cooler for an infrared space imaging satellite.
- Provided assistance to the Senior Mechanical Design Engineer including design development, mechanical analysis, detailed drawings, and fit/function analysis.

AWARDS:

1999 – On-the-Spot Performance Award.
1999 – On-the-Spot Performance Award, Laboratory Safety Program.
1998 – Star Performance Award, Tracy Fish Collection Facilities Improvement Program.
1997 – On-the-Spot Performance Award, Red Bluff Fish Passage Physical Model Study.
1996 – Star Performance Award, Glen-Colusa Irrigation District Fish Screen Facility.
1995 – Level N Performance Award.
1994 – On-the-Spot Performance Award, Shasta Temperature Control Device Connection.
1993 – Level N Performance Award.

SELECTED PUBLICATIONS:

Kubitschek, J.P., (1997), "Hydraulic Investigations Associated with Fish Passage at Red Bluff Diversion Dam. California," ASCE Proceedings *of* the *27th International* Association *for* Hydraulic Research (IAHR) Congress. Aug. 10-15, San Francisco, CA, Theme D, p. 405.

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Kubitschek, J.P. and Mefford, B., (1997), "Grand Valley Irrigation Company Diversion Dam Fish Passage Physical Model Study," U.S. Department of the Interior, Bureau of Reclamation, Report No. R-97-06.

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Kubitschek, J.P., (1997), "Physical Model Study of Enlarged Fish ladders at Red Bluff Diversion Dam," **U.S.** Department **of** the Interior, **Bureau** of Reclamation, Report No. R-97-08.

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Mefford, B. and Kubitschek, J.P., (1998), "Physical Model Studies of the GCID Pumping Plant Pish Screen Structure Alternatives: Progress Report No. 2 - 1:30 Scale Model Investigations: Alternative A," **U.S.** Department of the Interior, **Bureau** of Reclamation, Report No. R-98-03.

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CONFERENCE PRESENTATIONS:

Kubitschek, J.P. (1997). "Hydraulic Investigations Associated with Fish Passage at Red Bluff Diversion Darn," International Association of Hydraulic Research (IAHR) Congress, San Francisco, CA, August 10-15.

Kubitschek, J.P. (1997). "Evaluating the Hydraulic Performance of Fish Passage Structures," International Association of Hydraulic Research (IAHR) Congress, San Francisco, CA, August 10-15.

Kubitschek, **J.P.** (1997). "Hungry Horse Selective Withdrawal System," American Society of Civil Engineers (ASCE) Waterpower '97 Conference, Atlanta, **GA.** August ***5-8.***

PROFESSIONAL AFFILIATIONS:

P.E. License, State of Colorado, No. 32943, since 1997.

American Society of Mechanical Engineers (ASME), Associate Member since 1992.

S. Mark Nelson--Research Aquatic Biologist, Bureau of Reclamation

Professional experience:
Mr. Nelson has more than **15** years of experience in aquatic biology, ecotoxicology, toxicity testing, and invertebrate community ecology. Studies have included ***in situ*** toxicity testing of invertebrate communities in a metals impacted river, field surveys of lotic and lentic systems, and study of hyporheic invertebrate communities. Mr. Nelson has performed many studies examining effects of abiotic factors on aquatic organisms and has worked with fish, invertebrates, and periphyton in both field and laboratory settings.

Mr. Nelson would be responsible for study of invertebrates associated with salmonid redds and would install hyporheic pot samplers for sampling invertebrate communities and monitoring water quality.

Education:
MS., Fisheries, 1987, Colorado State University; B.S. Biology, 1978, Metropolitan State College.

Professional Societies:
American Entomological Society
North American Benthological Society-Member of **NABS** 1995 & 2000 Program Committees

Publications:

Area of expertise	Article
Fisheries	Nelson, S.M. and S.A. Flickinger. 1992. Salinity tolerance of Colorado Squawfish, *Ptychocheilus* ***lucius*** (Pisces: Cyprinidae). Hydrobiologia 246:165-168.
	Nelson, S.M. and L.C. Keenan. 1992. Use of an indigenous fish species, ***Fundulus zebrinus***, in a mosquito abatement program: a field comparison with the mosquitofish, ***Gambusia affini***. Journal of the American Mosquito Control Association 8:301-304.
Toxicity	Nelson, S.M., ***G.*** Mueller, and D.C. Hemphill. 1994. Identification of tire leachate toxicants and a risk assessment of water quality effects using tire reefs in canals. Bulletin of Environmental Contamination and Toxicology 52:574-581.
	Nelson, S.M. and R.A. Roline. 1998. Evaluation of the sensitivity of rapid toxicity tests relative to daphnid acute lethality tests. Bulletin of Environmental Contamination and Toxicology 60:292-299.

Hyporheic	Nelson, S.M., R.A. Roline, and **A.M.** Montano. 1993. Use of hyporheic samplers in assessing mine drainage impacts. Journal of Freshwater Ecology 8:103-110.
	Nelson, S.M. and R.A. Roline. 1999. Relationships between metals and hyporheic invertebrate community structure in a river recovering from metals contamination. Hydrobiologia 397:211-226.

ATTACHMENT F
BUDGET TABLES

2001 PSP Budget Table.

Summary Table
All Components Included

Year	Task	Total Cost
FY01	Field Work	$157,168
FY01	Laboratory Model	$79,060
FY02	Field Work	$143,018
FY02	Laboratory Model	$44,180
FY03	Field Work	$143,018
FY03	Laboratory Model	$56,640
Total Project Cost		$623,083

12001 PSP Budget Table.

Summary Table
Field Work Only - All Subcomponents

Year	Task	Total Cost
FY01	Field Work	$157,168
FY02	Field Work	$143,018
FY03	Field Work	$143,018
Total Project Cost		$443,203

12001 PSP Budget Table.

Summary Table
Laboratory Experiments Only

Year	Task	Total Cost
FY01	Laboratory Model	$79,060
FY02	Laboratory Model	$44,180
FY03	Laboratory Model	$56,640
Total Project Cost		$179,880

2001 PSP Budget Table.

Summary Table
Lab and Field Work - Temperature Only

Year	Task	Total Cost
FY01	Field Work	$131,635
FY01	Laboratory Model	$79,060
FY02	Field Work	$123,485
FY02	Laboratory Model	$44,180
FY03	Field Work	$123,485
FY03	Laboratory Model	$56,640
Total Project Cost		$558,485

2001 PSP Budget Table.

Summary Table
Lab and Field Work - Fine Sediments Only

Year	Task	Total Cost
FY01	Field Work	$145,995
FY01	Laboratory Model	$79,060
FY02	Field Work	$137,845
FY02	Laboratory Model	$44,180
FY03	Field Work	$137,845
FY03	Laboratory Model	$56,640
Total Project Cost		$601,565

2001 PSP Budget Table.

Summary Table
Lab and Field Work - Discharge Only

Year	Task	Total Cost
FY01	Field Work	$139,995
FY01	Laboratory Model	$79,060
FY02	Field Work	$131,845
FY02	Laboratory Model	$44,180
FY03	Field Work	$131,845
FY03	Laboratory Model	$56,640
Total Project Cost		$583,565

2001 PSP Budget Table.

Summary Table
Lab and Field Work - Temp. and Fine Sediments

Year	Task	Total Cost
FY01	Field Work	$149,995
FY01	Laboratory Model	$79,060
FY02	Field Work	$141,845
FY02	Laboratory Model	$44,180
FY03	Field Work	$137,845
FY03	Laboratory Model	$56,640
Total Project Cost		$609,565

2001 PSP Budget Table.

Summary Table
Lab and Field Work - Temp. and Discharge

Year	Task	Total Cost
FY01	Field Work	$141,995
FY01	Laboratory Model	$79,060
FY02	Field Work	$133,845
FY02	Laboratory Model	$44,180
FY03	Field Work	$133,845
FY03	Laboratory Model	$56,640
Total Project Cost		$589,565

2001 PSP Budget Table.

Summary Table
Lab and Field Work - Fine Sediments and Discharge

Year	Task	Total Cost
FY01	Field Work	$148,995
FY01	Laboratory Model	$79,060
FY02	Field Work	$140,845
FY02	Laboratory Model	$44,180
FY03	Field Work	$140,845
FY03	Laboratory Model	$56,640
Total Project Cost		$610,565

2001 PSP Budget Table. COMPONENT 1: FIELD WORK

Annual and total budget.

			Subject to Overhead							Exempt from Overhead		
Year	Task	Direct Labor Hours	Salary	Benefits	Travel	Supplies & Expendables	Service Contracts	Overhead (show % here)	Overhead $	Equipment	Graduate Student Fee Remission	Total Cost
FY01	Envir. Compliance	Lev. 2 - 80	$3,300	$720				33.0%	$1,980			$6,000
	Map Redds	Lev. 2 - 80	$3,300	$720	$2,000	$2,000		33.0%	$1,980			$10,000
	Map Redds	Lev. 1 - 80	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Map Redds	Grad St.	$13,000	$1,625	$8,680	$3,000		15.0%	$3,943	$3,000	$5,000	$38,228
	Constr. + Inst. Hyp. Pots	Lev. 2 - 120	$4,950	$1,080		$8,500		33.0%	$2,970			$17,500
	Constr. + Inst. Hyp. Pots	Lev. 1 - 80	$2,596	$566				33.0%	$1,558			$4,720
	Monitor Hyporh. + Eggs	Lev. 2 - 160	$3,300	$720	$2,000			33.0%	$1,980	$6,000		$14,000
	Monitor Hyporh. + Eggs	Lev. 1 - 160	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Remove Field Equip.	Lev. 2 - 80	$3,300	$720	$1,000			33.0%	$1,980			$7,000
	Remove Field Equip.	Lev. 1 - 80	$2,596	$566	$1,000			33.0%	$1,558			$5,720
	Meetings(CALFED)	Lev. 2 - 80	$3,300	$720	$3,000	$200		33.0%	$1,980			$9,200
	Data Analysis	Lev. 1 - 80	$2,596	$566		$800		33.0%	$1,558			$5,520
	Writing	Lev. 2 - 80	$3,300	$720	$2,000			33.0%	$1,980			$8,000
	Project Mngmt - BOR	Lev. 3 - 40	$1,958	$427				33.0%	$1,175			$3,560
	Project Mngmt - DCWC	800	IKS		$1,000			20.0%	$200			$1,200
	Outreach - DCWC	450	$9,900		$500	$500		20.0%	$2,180			$13,080
Total Cost Year 1			$62,585	$10,284	$25,160	$15,000	$0		$30,136	$9,000	$5,000	$157,168
FY02	Permit Activities	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Map Redds	Lev. 2 - 80	$3,300	$720	$2,000	$2,000		33.0%	$1,980			$10,000
	Map Redds	Lev. 1 - 80	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Map Redds	Grad St.	$13,000	$1,625	$8,680	$2,000		15.0%	$3,793		$1,000	$30,078
	Constr. + Inst. Hyp. Pots	Lev. 2 - 80	$3,300	$720		$8,500		33.0%	$1,980			$14,500
	Constr. + Inst. Hyp. Pots	Lev. 1 - 80	$2,596	$566				33.0%	$1,558			$4,720
	Monitor Hyporh. + Eggs	Lev. 2 - 160	$3,300	$720	$2,000			33.0%	$1,980	$6,000		$14,000
	Monitor Hyporh. + Eggs	Lev. 1 - 160	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Remove Field Equip.	Lev. 2 - 80	$3,300	$720	$1,000			33.0%	$1,980			$7,000
	Remove Field Equip.	Lev. 1 - 80	$2,596	$566	$1,000			33.0%	$1,558			$5,720
	Meetings(CALFED)	Lev. 2 - 80	$3,300	$720	$3,000	$200		33.0%	$1,980			$9,200
	Data Analysis	Lev. 1 - 80	$2,596	$566		$800		33.0%	$1,558			$5,520
	Writing	Lev. 2 - 80	$3,300	$720	$2,000			33.0%	$1,980			$8,000
	Project Mngmt - BOR	Lev. 3 - 40	$1,958	$427				33.0%	$1,175			$3,560
	Project Mngmt - DCWC	800	IKS		$1,000			20.0%	$200			$1,200
	Outreach - DCWC	450	$9,900		$500	$500		20.0%	$2,180			$13,080
Total Cost Year 2			$59,288	$9,564	$25,160	$14,000	$0		$28,006	$6,000	$1,000	$143,018
FY03	Records and Samples	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Map Redds	Lev. 2 - 80	$3,300	$720	$2,000	$2,000		33.0%	$1,980			$10,000
	Map Redds	Lev. 1 - 80	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Map Redds	Grad St.	$13,000	$1,625	$8,680	$2,000		15.0%	$3,793		$1,000	$30,078
	Constr. + Inst. Hyp. Pots	Lev. 2 - 80	$3,300	$720		$8,500		33.0%	$1,980			$14,500
	Constr. + Inst. Hyp. Pots	Lev. 1 - 80	$2,596	$566				33.0%	$1,558			$4,720
	Monitor Hyporh. + Eggs	Lev. 2 - 160	$3,300	$720	$2,000			33.0%	$1,980	$6,000		$14,000
	Monitor Hyporh. + Eggs	Lev. 1 - 160	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Remove Field Equip.	Lev. 2 - 80	$3,300	$720	$1,000			33.0%	$1,980			$7,000
	Remove Field Equip.	Lev. 1 - 80	$2,596	$566	$1,000			33.0%	$1,558			$5,720
	Meetings(CALFED, AFS)	Lev. 2 - 80	$3,300	$720	$3,000	$200		33.0%	$1,980			$9,200
	Data Analysis	Lev. 1 - 80	$2,596	$566		$800		33.0%	$1,558			$5,520
	Writing	Lev. 2 - 80	$3,300	$720	$2,000			33.0%	$1,980			$8,000
	Project Mngmt - BOR	Lev. 3 - 40	$1,958	$427				33.0%	$1,175			$3,560
	Project Mngmt - DCWC	800	IKS		$1,000			20.0%	$200			$1,200
	Outreach - DCWC	450	$9,900		$500	$500		20.0%	$2,180			$13,080
Total Cost Year 3			$59,288	$9,564	$25,160	$14,000	$0		$28,006	$6,000	$1,000	$143,018
Total Project Cost			$181,164	$29,413	$75,480	$43,000	$0		$86,147	$21,000	$7,000	$443,203

2001 PSP Budget Table.		COMPONENT 1:	FIELD WORK									
		Sub-Component:	Temperature Only									
Annual and total budget.												
					Subject to Overhead					Exempt from Overhead		
Year	Task	Direct Labor Hours	Salary	Benefits	Travel	Supplies & Expendables	Service Contracts	Overhead (show % here)	Overhead $	Equipment	Graduate Student Fee Remission	Total Cost
FY01	Envir. Compliance	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Map Redds	Lev. 2 - 80	$3,300	$720	$1,000	$1,000		33.0%	$1,980			$8,000
	Map Redds	Lev. 1 - 40	$1,478	$322	$1,000			33.0%	$887			$3,687
	All Activities	Grad St.	$13,000	$1,625	$8,660	$3,000		15.0%	$3,943	$3,000	$5,000	$38,228
	Constr. + Inst. Hyp. Pots	Lev. 2 - 120	$4,950	$1,080		$4,000		33.0%	$2,970			$13,000
	Constr. + Inst. Hyp. Pots	Lev. 1 - 80	$2,596	$566				33.0%	$1,558			$4,720
	Monitor Hyporh. + Eggs	Lev. 2 - 80	$1,650	$360	$1,000			33.0%	$990	$2,000		$6,000
	Monitor Hyporh. + Eggs	Lev. 1 - 160	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Remove Field Equip.	Lev. 2 - 40	$1,650	$360	$1,000			33.0%	$990			$4,000
	Remove Field Equip.	Lev. 1 - 80	$2,596	$566	$1,000			33.0%	$1,558			$5,720
	Meetings(CALFED)	Lev. 2 - 80	$3,300	$720	$3,000	$200		33.0%	$1,980			$9,200
	Data Analysis	Lev. 1 - 80	$2,596	$566		$800		33.0%	$1,558			$5,520
	Writing	Lev. 2 - 80	$3,300	$720				33.0%	$1,980			$6,000
	Project Mngmt - BOR	Lev. 3 - 40	$1,958	$427				33.0%	$1,175			$3,560
	Project Mngmt - DCWC	800	IKS		$1,000			20.0%	$200			$1,200
	Outreach - DCWC	450	$9,900		$500	$500		20.0%	$2,180			$13,080
Total Cost Year 1			$56,520	$8,960	$20,160	$9,500	$0		$26,495	$5,000	$5,000	$131,635
FY02	Permit Activities	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Map Redds	Lev. 2 - 80	$3,300	$720	$1,000	$1,000		33.0%	$1,980			$8,000
	Map Redds	Lev. 1 - 40	$1,478	$322	$1,000			33.0%	$887			$3,687
	All Activities	Grad St.	$13,000	$1,625	$8,660	$2,000		15.0%	$3,793		$1,000	$30,078
	Constr. + Inst. Hyp. Pots	Lev. 2 - 120	$4,950	$1,080		$4,000		33.0%	$2,970			$13,000
	Constr. + Inst. Hyp. Pots	Lev. 1 - 80	$2,596	$566				33.0%	$1,558			$4,720
	Monitor Hyporh. + Eggs	Lev. 2 - 80	$1,650	$360	$1,000			33.0%	$990	$2,000		$6,000
	Monitor Hyporh. + Eggs	Lev. 1 - 160	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Remove Field Equip.	Lev. 2 - 40	$1,650	$360	$1,000			33.0%	$990			$4,000
	Remove Field Equip.	Lev. 1 - 80	$2,596	$566	$1,000			33.0%	$1,558			$5,720
	Meetings(CALFED)	Lev. 2 - 80	$3,300	$720	$3,000	$200		33.0%	$1,980			$9,200
	Data Analysis	Lev. 1 - 80	$2,596	$566		$800		33.0%	$1,558			$5,520
	Writing	Lev. 2 - 80	$3,300	$720				33.0%	$1,980			$6,000
	Project Mngmt - BOR	Lev. 3 - 40	$1,958	$427				33.0%	$1,175			$3,560
	Project Mngmt - DCWC	800	IKS		$1,000			20.0%	$200			$1,200
	Outreach - DCWC	450	$9,900		$500	$500		20.0%	$2,180			$13,080
Total Cost Year 2			$56,520	$8,960	$20,160	$8,500	$0		$26,345	$2,000	$1,000	$123,485
FY03	Records & Sample Depos.	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Map Redds	Lev. 2 - 80	$3,300	$720	$1,000	$1,000		33.0%	$1,980			$8,000
	Map Redds	Lev. 1 - 40	$1,478	$322	$1,000			33.0%	$887			$3,687
	All Activities	Grad St.	$13,000	$1,625	$8,660	$2,000		15.0%	$3,793		$1,000	$30,078
	Constr. + Inst. Hyp. Pots	Lev. 2 - 120	$4,950	$1,080		$4,000		33.0%	$2,970			$13,000
	Constr. + Inst. Hyp. Pots	Lev. 1 - 80	$2,596	$566				33.0%	$1,558			$4,720
	Monitor Hyporh. + Eggs	Lev. 2 - 80	$1,650	$360	$1,000			33.0%	$990	$2,000		$6,000
	Monitor Hyporh. + Eggs	Lev. 1 - 160	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Remove Field Equip.	Lev. 2 - 40	$1,650	$360	$1,000			33.0%	$990			$4,000
	Remove Field Equip.	Lev. 1 - 80	$2,596	$566	$1,000			33.0%	$1,558			$5,720
	Meetings(CALFED)	Lev. 2 - 80	$3,300	$720	$3,000	$200		33.0%	$1,980			$9,200
	Data Analysis	Lev. 1 - 80	$2,596	$566		$800		33.0%	$1,558			$5,520
	Writing	Lev. 2 - 80	$3,300	$720				33.0%	$1,980			$6,000
	Project Mngmt - BOR	Lev. 3 - 40	$1,958	$427				33.0%	$1,175			$3,560
	Project Mngmt - DCWC	800	IKS		$1,000			20.0%	$200			$1,200
	Outreach - DCWC	450	$9,900		$500	$500		20.0%	$2,180			$13,080
Total Cost Year 3			$56,520	$8,960	$20,160	$8,500	$0		$26,345	$2,000	$1,000	$123,485
Total Project Cost			$169,560	$26,881	$60,480	$26,500	$0		$79,184	$9,000	$7,000	$378,605

2001 PSP Budget Table.		COMPONENT 1:	FIELD WORK									
		Sub-Component:	Fine Sediments Only									
Annual and total budget.												
			Subject to Overhead							Exempt from Overhead		
Year	Task	Direct Labor Hours	Salary	Benefits	Travel	Supplies & Expendables	Service Contracts	Overhead (show % here)	Overhead $	Equipment	Graduate Student Fee Remission	Total Cost
FY01	Envir. Compliance	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Map Redds	Lev. 2 - 80	$3,300	$720	$1,000	$1,000		33.0%	$1,980			$8,000
	Map Redds	Lev. 1 - 40	$1,478	$322	$1,000			33.0%	$887			$3,687
	All Activities	Grad St.	$13,000	$1,625	$8,660	$3,000		15.0%	$3,943	$3,000	$5,000	$38,228
	Constr. + Inst. Hyp. Pots	Lev. 2 - 120	$4,950	$1,080		$4,000		33.0%	$2,970			$13,000
	Constr. + Inst. Hyp. Pots	Lev. 1 - 80	$2,596	$566				33.0%	$1,558			$4,720
	Monitor Hyporh. + Eggs	Lev. 2 - 160	$6,600	$1,440	$1,000	$3,000		33.0%	$3,960	$2,000		$18,000
	Monitor Hyporh. + Eggs	Lev. 1 - 160	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Remove Field Equip.	Lev. 2 - 40	$1,650	$360	$1,000			33.0%	$990			$4,000
	Remove Field Equip.	Lev. 1 - 80	$2,596	$566	$1,000			33.0%	$1,558			$5,720
	Meetings(CALFED)	Lev. 2 - 80	$3,300	$720	$3,000	$200		33.0%	$1,980			$9,200
	Data Analysis	Lev. 1 - 120	$3,894	$850		$800		33.0%	$2,336			$7,880
	Writing	Lev. 2 - 80	$3,300	$720				33.0%	$1,980			$6,000
	Project Mngmt - BOR	Lev. 3 - 40	$1,958	$427				33.0%	$1,175			$3,560
	Project Mngmt - DCWC	800	IKS		$1,000			20.0%	$200			$1,200
	Outreach - DCWC	450	$9,900		$500	$500		20.0%	$2,180			$13,080
Total Cost Year 1			$62,768	$10,323	$20,160	$12,500	$0		$30,244	$5,000	$5,000	$145,995
FY02	Permit Activities	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Map Redds	Lev. 2 - 80	$3,300	$720	$1,000	$1,000		33.0%	$1,980			$8,000
	Map Redds	Lev. 1 - 40	$1,478	$322	$1,000			33.0%	$887			$3,687
	All Activities	Grad St.	$13,000	$1,625	$8,660	$2,000		15.0%	$3,793		$1,000	$30,078
	Constr. + Inst. Hyp. Pots	Lev. 2 - 120	$4,950	$1,080		$4,000		33.0%	$2,970			$13,000
	Constr. + Inst. Hyp. Pots	Lev. 1 - 80	$2,596	$566				33.0%	$1,558			$4,720
	Monitor Hyporh. + Eggs	Lev. 2 - 160	$6,600	$1,440	$1,000	$3,000		33.0%	$3,960	$2,000		$18,000
	Monitor Hyporh. + Eggs	Lev. 1 - 160	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Remove Field Equip.	Lev. 2 - 40	$1,650	$360	$1,000			33.0%	$990			$4,000
	Remove Field Equip.	Lev. 1 - 80	$2,596	$566	$1,000			33.0%	$1,558			$5,720
	Meetings(CALFED)	Lev. 2 - 80	$3,300	$720	$3,000	$200		33.0%	$1,980			$9,200
	Data Analysis	Lev. 1 - 120	$3,894	$850		$800		33.0%	$2,336			$7,880
	Writing	Lev. 2 - 80	$3,300	$720				33.0%	$1,980			$6,000
	Project Mngmt - BOR	Lev. 3 - 40	$1,958	$427				33.0%	$1,175			$3,560
	Project Mngmt - DCWC	800	IKS		$1,000			20.0%	$200			$1,200
	Outreach - DCWC	450	$9,900		$500	$500		20.0%	$2,180			$13,080
Total Cost Year 2			$62,768	$10,323	$20,160	$11,500	$0		$30,094	$2,000	$1,000	$137,845
FY03	Records & Sample Depos.	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Map Redds	Lev. 2 - 80	$3,300	$720	$1,000	$1,000		33.0%	$1,980			$8,000
	Map Redds	Lev. 1 - 40	$1,478	$322	$1,000			33.0%	$887			$3,687
	All Activities	Grad St.	$13,000	$1,625	$8,660	$2,000		15.0%	$3,793		$1,000	$30,078
	Constr. + Inst. Hyp. Pots	Lev. 2 - 120	$4,950	$1,080		$4,000		33.0%	$2,970			$13,000
	Constr. + Inst. Hyp. Pots	Lev. 1 - 80	$2,596	$566				33.0%	$1,558			$4,720
	Monitor Hyporh. + Eggs	Lev. 2 - 160	$6,600	$1,440	$1,000	$3,000		33.0%	$3,960	$2,000		$18,000
	Monitor Hyporh. + Eggs	Lev. 1 - 160	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Remove Field Equip.	Lev. 2 - 40	$1,650	$360	$1,000			33.0%	$990			$4,000
	Remove Field Equip.	Lev. 1 - 80	$2,596	$566	$1,000			33.0%	$1,558			$5,720
	Meetings(CALFED)	Lev. 2 - 80	$3,300	$720	$3,000	$200		33.0%	$1,980			$9,200
	Data Analysis	Lev. 1 - 120	$3,894	$850		$800		33.0%	$2,336			$7,880
	Writing	Lev. 2 - 80	$3,300	$720				33.0%	$1,980			$6,000
	Project Mngmt - BOR	Lev. 3 - 40	$1,958	$427				33.0%	$1,175			$3,560
	Project Mngmt - DCWC	800	IKS		$1,000			20.0%	$200			$1,200
	Outreach - DCWC	450	$9,900		$500	$500		20.0%	$2,180			$13,080
Total Cost Year 3			$62,768	$10,323	$20,160	$11,500	$0		$30,094	$2,000	$1,000	$137,845
Total Project Cost			$188,304	$30,970	$60,480	$35,500	$0		$90,431	$9,000	$7,000	$421,685

2001 PSP Budget Table.		COMPONENT 1:	FIELD WORK									
		Sub-Component:	Discharge Only									
Annual and total budget.												
					Subject to Overhead					Exempt from Overhead		
Year	Task	Direct Labor Hours	Salary	Benefits	Travel	Supplies & Expendables	Service Contracts	Overhead (show % here)	Overhead $	Equipment	Graduate Student Fee Remission	Total Cost
FY01	Envir. Compliance	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Map Redds	Lev. 2 - 80	$3,300	$720	$1,000	$1,000		33.0%	$1,980			$8,000
	Map Redds	Lev. 1 - 40	$1,478	$322	$1,000			33.0%	$887			$3,687
	All Activities	Grad St.	$13,000	$1,625	$8,660	$3,000		15.0%	$3,943	$5,000	$5,000	$38,228
	Constr. + Inst. Hyp. Pots	Lev. 2 - 80	$3,300	$720		$4,000		33.0%	$1,980			$10,000
	Constr. + Inst. Hyp. Pots	Lev. 1 - 80	$2,596	$566				33.0%	$1,558			$4,720
	Monitor Hyporh. + Eggs	Lev. 2 - 120	$4,950	$1,080	$1,000	$3,000		33.0%	$2,970	$2,000		$15,000
	Monitor Hyporh. + Eggs	Lev. 1 - 160	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Remove Field Equip.	Lev. 2 - 40	$1,650	$360	$1,000			33.0%	$990			$4,000
	Remove Field Equip.	Lev. 1 - 80	$2,596	$566	$1,000			33.0%	$1,558			$5,720
	Meetings(CALFED)	Lev. 2 - 80	$3,300	$720	$3,000	$200		33.0%	$1,980			$9,200
	Data Analysis	Lev. 1 - 120	$3,894	$850		$800		33.0%	$2,336			$7,880
	Writing	Lev. 2 - 80	$3,300	$720				33.0%	$1,980			$6,000
	Project Mngmt - BOR	Lev. 3 - 40	$1,958	$427				33.0%	$1,175			$3,560
	Project Mngmt - DCWC	800	IKS		$1,000			20.0%	$200			$1,200
	Outreach - DCWC	450	$9,900		$500	$500		20.0%	$2,180			$13,080
Total Cost Year 1			$59,468	$9,603	$20,160	$12,500	$0		$28,264	$5,000	$5,000	$139,995
FY02	Permit Activities	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Map Redds	Lev. 2 - 80	$3,300	$720	$1,000	$1,000		33.0%	$1,980			$8,000
	Map Redds	Lev. 1 - 40	$1,478	$322	$1,000			33.0%	$887			$3,687
	All Activities	Grad St.	$13,000	$1,625	$8,660	$2,000		15.0%	$3,793		$1,000	$30,078
	Constr. + Inst. Hyp. Pots	Lev. 2 - 80	$3,300	$720		$4,000		33.0%	$1,980			$10,000
	Constr. + Inst. Hyp. Pots	Lev. 1 - 80	$2,596	$566				33.0%	$1,558			$4,720
	Monitor Hyporh. + Eggs	Lev. 2 - 120	$4,950	$1,080	$1,000	$3,000		33.0%	$2,970	$2,000		$15,000
	Monitor Hyporh. + Eggs	Lev. 1 - 160	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Remove Field Equip.	Lev. 2 - 40	$1,650	$360	$1,000			33.0%	$990			$4,000
	Remove Field Equip.	Lev. 1 - 80	$2,596	$566	$1,000			33.0%	$1,558			$5,720
	Meetings(CALFED)	Lev. 2 - 80	$3,300	$720	$3,000	$200		33.0%	$1,980			$9,200
	Data Analysis	Lev. 1 - 120	$3,894	$850		$800		33.0%	$2,336			$7,880
	Writing	Lev. 2 - 80	$3,300	$720				33.0%	$1,980			$6,000
	Project Mngmt - BOR	Lev. 3 - 40	$1,958	$427				33.0%	$1,175			$3,560
	Project Mngmt - DCWC	800	IKS		$1,000			20.0%	$200			$1,200
	Outreach - DCWC	450	$9,900		$500	$500		20.0%	$2,180			$13,080
Total Cost Year 2			$59,468	$9,603	$20,160	$11,500	$0		$28,114	$2,000	$1,000	$131,845
FY03	Records & Sample Depos.	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Map Redds	Lev. 2 - 80	$3,300	$720	$1,000	$1,000		33.0%	$1,980			$8,000
	Map Redds	Lev. 1 - 40	$1,478	$322	$1,000			33.0%	$887			$3,687
	All Activities	Grad St.	$13,000	$1,625	$8,660	$2,000		15.0%	$3,793		$1,000	$30,078
	Constr. + Inst. Hyp. Pots	Lev. 2 - 80	$3,300	$720		$4,000		33.0%	$1,980			$10,000
	Constr. + Inst. Hyp. Pots	Lev. 1 - 80	$2,596	$566				33.0%	$1,558			$4,720
	Monitor Hyporh. + Eggs	Lev. 2 - 120	$4,950	$1,080	$1,000	$3,000		33.0%	$2,970	$2,000		$15,000
	Monitor Hyporh. + Eggs	Lev. 1 - 160	$2,596	$566	$2,000			33.0%	$1,558			$6,720
	Remove Field Equip.	Lev. 2 - 40	$1,650	$360	$1,000			33.0%	$990			$4,000
	Remove Field Equip.	Lev. 1 - 80	$2,596	$566	$1,000			33.0%	$1,558			$5,720
	Meetings(CALFED)	Lev. 2 - 80	$3,300	$720	$3,000	$200		33.0%	$1,980			$9,200
	Data Analysis	Lev. 1 - 120	$3,894	$850		$800		33.0%	$2,336			$7,880
	Writing	Lev. 2 - 80	$3,300	$720				33.0%	$1,980			$6,000
	Project Mngmt - BOR	Lev. 3 - 40	$1,958	$427				33.0%	$1,175			$3,560
	Project Mngmt - DCWC	800	IKS		$1,000			20.0%	$200			$1,200
	Outreach - DCWC	450	$9,900		$500	$500		20.0%	$2,180			$13,080
Total Cost Year 3			$59,468	$9,603	$20,160	$11,500	$0		$28,114	$2,000	$1,000	$131,845
Total Project Cost			$178,404	$28,810	$60,480	$35,500	$0		$84,491	$9,000	$7,000	$403,685

2001 PSP Budget Table.		COMPONENT 2:	Laboratory Work									
Annual and total budget.												
			Subject to Overhead							Exempt from Overhead		
Year	Task	Direct Labor Hours	Salary	Benefits	Travel	Supplies & Expendables	Service Contracts	Overhead (show % here)	Overhead $	Equipment	Graduate Student Fee Remission	Total Cost
FY01	Envir. Compliance	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Dsgn. + Const. Model	Lev. 2 - 120	$4,950	$1,080		$4,000		33.0%	$2,970	$9,000		$22,000
	Construction of Model	Lev. 1 - 280	$9,086	$1,982		$1,000		33.0%	$5,452			$17,520
	Model Expt.s	Lev. 2 - 120	$4,950	$1,080		$2,000		33.0%	$2,970	$2,000		$13,000
	Model Expt.s	Lev. 1 - 160	$5,192	$1,133				33.0%	$3,115			$9,440
	Data Manipulation	Lev. 2 - 80	$3,300	$720		$400		33.0%	$1,980			$6,400
	Writing	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Meetings(CALFED)	Lev. 2 - 40	$1,650	$360	$1,500	$200		33.0%	$990			$4,700
	Project Mngmt - DCWC	80	IKS									$0
Total Cost Year 1			$32,428	$7,075	$1,500	$7,600	$0		$19,457	$11,000	$0	$79,060
FY02	Permit Activities	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Model Expt.s	Lev. 2 - 120	$4,950	$1,080		$4,000		33.0%	$2,970	$2,000		$15,000
	Model Expt.s	Lev. 1 - 120	$3,894	$850		$3,000		33.0%	$2,336	$2,000		$12,080
	Data Manipulation	Lev. 2 - 80	$3,300	$720		$400		33.0%	$1,980			$6,400
	Writing	Lev. 2 - 40	$1,650	$360				33.0%	$990			$3,000
	Meetings(CALFED)	Lev. 2 - 40	$1,650	$360	$1,500	$200		33.0%	$990			$4,700
	Project Mngmt - DCWC	80	IKS									$0
Total Cost Year 2			$17,094	$3,730	$1,500	$7,600	$0		$10,256	$4,000	$0	$44,180
FY03	Model Expt.s	Lev. 2 - 120	$4,950	$1,080		$4,000		33.0%	$2,970	$2,000		$15,000
	Model Expt.s	Lev. 1 - 120	$3,894	$850		$3,000		33.0%	$2,336	$2,000		$12,080
	Data Manipulation	Lev. 2 - 120	$7,788	$1,699		$200		33.0%	$4,673			$14,360
	Writing	Lev. 2 - 120	$4,950	$1,080				33.0%	$2,970			$9,000
	Meetings(CALFED)	Lev. 2 - 80	$1,650	$360	$3,000	$200		33.0%	$990			$6,200
	Project Mngmt - DCWC	80	IKS									$0
Total Cost Year 3			$23,232	$5,069	$3,000	$7,400	$0		$13,939	$4,000	$0	$56,640
Total Project Cost			$72,754	$15,874	$6,000	$22,600	$0		$43,652	$19,000	$0	$179,880

ATTACHMENT G
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ATTACHMENT H
THRESHOLD REQUIREMENTS

Environmental Compliance Checklist

All applicants must fill out this Environmental Compliance Checklist. Applications must contain answers to the following questions to be responsive and to be considered for funding. ***Failure to answer these questions and include them with the application will result in the application being considered nonresponsive and not considered forfunding.***

1. **Do** any **of** the actions included in the proposal require compliance with either the California Environmental Quality Act (CEQA), the National Environmental Policy Act (NEPA), or both?

X
YES ______ **NO**

□ If you answered yes to # **1,** identify the lead governmental agency **for** CEQA/NEPA compliance.

__**US** Bureau ***of*** Reclamation__
Lead Agency

□ If you answered **no** to # 1, explain why CEQA/NEPA compliance is not required **for** the actions in the proposal.

4. If CEQA/NEPA compliance is required, describe how the project will comply with either **or** both **of** these laws.

CEQA We will complete and file an Initial Study, Environmental Information Form.
NEPA This project may qualify for a categorical exclusion (516 DM 6, Appendix 9). We will complete an assessment with our NEPA and legal staffs.

Describe where the project **is** in the compliance process and the expected date **of** completion.

For CEQA and NEPA we have acquired the appropriate forms initiated the process with our legal staff to determine appropriate actions.

5. **Will** the applicant require access across public **or** private property that the applicant does not **own** to accomplish the activities in the proposal?

__X__
YES ______ NO

If yes, the applicant must attach written permission **for** access from the relevant property owner(s). Failure to include written permission **for** access may result in disqualification **of** the proposal during the review process. Research and monitoring field projects **for** which specific field locations have not been identified will be required to provide access needs and permission for access with **30** days **of** notification **of** approval.

Please see the letter, at the end of Attachment D, from Bill Berens. Mr. Berens is a local landowner and President of the Deer Creek Watershed Conservancy.

6. Please indicate what permits **or** other approvals may be required **for** the activities contained in your proposal. Check all boxes that apply.

LOCAL
Conditional use permit ___
Variance ___
Subdivision Map Act approval ___
Grading permit ___
General plan amendment ___
Specific plan approval ___
Rezone ___
Williamson Act Contract
cancellation ___
Other ___
(please specify)
None required _X_

STATE
CESA Compliance _X_ (CDFG)
Streambed alteration permit ___ (CDFG)
CWA § **401** certification ___ (RWQCB)
Coastal development permit ___ (Coastal Commission/BCDC)
Reclamation Board approval ___
Notification ___ (DPC, BCDC)
Other _Scientific Collection Permit (CDFG) - Already obtained - See attached copy_
(please specify)
None required ___

FEDERAL
ESA Consultation _X_ (USFWS)
Rivers & Harbors Act permit ___ (ACOE)
CWA § **404** permit ___ (ACOE)
Other ___
@leasespecify)
None **required** ___

DPC = Delta Protection Commission
CWA =Clean Water Act **ESA =** Endangered Species Act
CESA = California Endangered Species Act CDFG = California Department of Fish and **Game**
USFWS = U.S. Fish and Wildlife Service RWQCB = Regional Water Quality Control Board
ACOE = U.S. Amy Corps of Engineers BCDC= Bay Conservation and Development Comm.

Land Use Checklist

All applicants must fill out this Land Use Checklist for their proposal. Applications must contain answers to the following questions to be responsive and to be considered for funding. ***Failure to answer these questions and include them with the application will result in the application being considered nonresponsive and not considered forfunding.***

1. Do the actions in the proposal involve physical changes to the land(i.e. grading, planting vegetation, **or** breeching levees) **or** restrictions in land use (i.e. conservation easement **or** placement of land in a wildlife refuge)?

______ **YES** 			__X__ **NO**

2. **If NO to # 1,** explain what type **of** actions are involved in the proposal (**i.e.,** research only, planning only).

This is a research proposal. Actions **on** the ground are small and will cause no permanent change in stream flow, vegetation, or land use.

3. If YES to # **1,** what is the proposed land use change or restriction under the proposal?

4. If YES to **# 1,** is the land currently under a Williamson Act contract?

______ **YES** 			______ **NO**

5. If YES to # **1,** answer the following:

Current land use ____________________
Current zoning ____________________
Current general plan designation ____________________

6. If YES to **#1, is** the land classified as Prime Farmland, Farmland of Statewide Importance or Unique Farmland **on** the Department of Conservation Important Farmland Maps?

______ **YES** 	______ **NO** 	______ **DON'T KNOW**

7. If YES to **# 1,** how many **acres of** land **will** be subject to physical change **or** land use restrictions under the proposal?

____

8. If **YES** to **#** 1, is the property currently being commercially farmed **or** grazed?

______ **YES** 			______ **NO**

9. If **YES to #8,** what are the number **of** employees/acre__________
the total number of employees __________

United States Department of the Interior

BUREAU OF RECLAMATION
Reclamation **Service** Center
P.O. Box **25007**
Building 67, Denver **Federal** Center
Denver, Colorado 80225-0007

IN **REPLY REFERTO:**

Tehama County Board of Supervisors
Ross Turner, Chair
PO Box 250
Red Bluff, CA 96080

May 11, 2000

Mr. Turner:

Please be advised that the US Bureau of Reclamation and the Deer Creek Watershed Conservancy have submitted a research proposal, as a joint venture, to the CALFED Bay-Delta program entitled:

The Influence of Discharge, Temperature, and Fine Sediment on the Hyporheic Zone: Intragravel Conditions and Anadromous Salmonid Eggs in Redds

This letter may serve as your official notification of this proposed research. Activities that might occur if the proposal is supported are installation of redd caps, hyporheic pots, and incubation tubes into the substrate of the Sacramento River and Deer Creek. These apparati will be used to monitor salmonid reproductive success, water chemistry, and fine sediment deposition in redds. In addition, piezometers that extend slightly above the water's surface may be placed in remote locations.

If supported, the work would take place October, 2000 to September, 2003. Field work would be concentrated during the period in which fall chinook salmon spawn and incubate their eggs in redds. Approximately, this period is October 1to March 31.

Sincerely,

Mark D. Bowen

Mark D. Bowen, Ph.D.
Fishery Biologist
US Bureau of Reclamation
P.O. Box 25007
Denver, CO 80225-8290

United States Department of the Interior

BUREAU OF RECLAMATION
Reclamation **Service** Center
P.O.Box 25007
Building 67. Denver **Federal** Center
Denver, Colorado 80225-0007

IN REPLY REFER TO:

Shasta County Board of Supervisors
Richard Dickerson, Chair
Redding, CA 96001

May 11,2000

Mr. Dickerson:

Please be advised that the **US** Bureau of Reclamation and the Deer Creek Watershed Conservancy have submitted a research proposal, as a joint venture, to the CALFED Bay-Delta program entitled:

The Influence of Discharge, Temperature, and Fine Sediment on the Hyporheic Zone: Intragravel Conditions and Anadromous Salmonid Eggs in Redds

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Sincerely,

Mark D. Bowen

Mark D. Bowen, Ph.D.
Fishery Biologist
US Bureau of Reclamation
P.O. Box 25007
Denver, CO 80225-8290

ATTACHMENT I
LETTER OF SUPPORT

United States Department of Agriculture

Forest Service

Lassen National Forest

Almanor Ranger District
P.O. Box 767
Chester, Ca 96028
(530) 258-2141 Voice/TTY

File Code: 2620

Date: May 8,2000

Dr. Mark Bowen
United States Bureau of Reclamation
6" and Kipling
Room 152, Building **67**
Denver, Colorado 80225

Dr. Bowen

Thank you for the opportunity to discuss and review your CALFED Research Proposal "Hyporheic Flow Effects on Anadromous Salmonid Eggs in Redds". The purpose of this letter is to offer support for the proposal. As you know, the Lassen National Forest's Watershed Analysis identified sediment regime as one watershed process that had been altered significantly from it's historic condition. While we believe that treating sources of increased erosion can only improve watershed resiliency and provide improved protection for aquatic resources in our anadromous watersheds, there is no doubt that research to quantify the effects of sediment on chinook egg survival in Deer Creek would be of great benefit to those managing these watersheds.

We strongly support your efforts to research this problem, and for any work on Forest Service lands, can offer support from our staff to assist in data collection, inventories and surveys. Information from our previous survey, monitoring and inventory work is available to you, should it be of interest.

Ple se let me w how we can be of further assistance.

GARY SMITH

Acting District Ranger

ATTACHMENT J

LANDOWNER LETTER

CALFED Bay-Delta Program
1416 Ninth Street, Suite 1155
Sacramento, CA 95814

May 9,2000

To whom it may concern:

The US Bureau of Reclamation (Reclamation) and Deer Creek Watershed Conservancy (DCWC) have entered into a joint venture to collect data useful to each for meeting their respective management needs. As a local land-owner, I give permission to Reclamation and DCWC employees to access Deer Creek by my property in the course of the activities necessary for the completion of this research.

Furthermore, I am President of the Deer Creek Watershed Conservancy. The Conservancy is partially comprised of land-owners throughout the Deer Creek watershed: a number of land-owners in DCWC will consent to allow access to Deer Creek via their private property.

Because the exact locations of fall chinook salmon redds cannot be predicted, it is not possible to provide written permission from each property owner chat will be required. So, Reclamation and the DCWC will pursue permission as necessary in the Autumn.

Sincerely,

Bill Berens

Bill Berens
President,
Deer Creek Watershed Conservancy

ATTACHMENT K
STATEMENT OF JOINT VENTURE PARTNERSHIP
RESPONSIBILITIES OF PARTNERS

United States Department of the Interior

BUREAU OF RECLAMATION
Reclamation Service Center
P.O. Box 25007
Building 67, Denver Federal Center
Denver, Colorado 80225-0007

IN REPLY REFER TO:

Statement of Joint Venture Partnership
CALFED Proposal of US Bureau of Reclamation and the Deer Creek Watershed Conservancy
May 15,2000

The United States Bureau of Reclamation (Reclamation) and the Deer Creek Watershed Conservancy (DCWC) have developed this proposal for research entitled:

The influence of discharge, temperature, and fine sediment on the hyporheic zone: intragravel conditions and anadromous salmonid egg survival.

Reclamation and DCWC have developed the proposed research because the research will provide data of mutual interest to each party. And the information will be useful to each entity in addressing the management needs of each party.

The contracting entity will be the US Bureau of Reclamation and will be responsible for payments, reporting, and accounting. Reclamation will provide the expertise to conduct the research. DCWC will provide outreach to land owners and the public with respect to the research. **A** detailed description follows describing how the partners will operate. This description includes decision-making authority, liability, and tasks to be performed by each entity. Costs may be found in the budget at the end of the proposal.

Mark D. Bowen
Printed name of applicant
Fishery Biologist,
US Bureau of Reclamation

Mark D. Bowen
Signature of applicant

DiAnne Gaumer
Printed name of joint venture applicant
Executive Director,
Deer Creek Watershed Conservancy

DiAnne Gaumer
Signature of joint venture applicant

Description of Operations
US Bureau of Reclamation and Deer Creek Watershed Conservancy

This description of joint operaticns for the US Bureau of Reclamation (Reclamation) and the Deer Creek Watershed Conservancy (DCWC) pertains only to the proposal jointly submitted to CALFED Bay-Delta Program (May 15,2000).

Reclamation and the DCWC will convene a meeting each year before the initiation of activities on October 1 (first day of the federal fiscal year) for the upcoming period 10/1 - 9/30. At this meeting the parties will decide: the overall program direction, fund allocation, and field work, laboratory, and outreach tasks for the coming year. Within this agreed-to framework by both parties, decision-making authority will rest with the following parties/entities:

Field work will be under the supervision of Reclamation and the principal investigator, Mark Bowen. Two board members of the DCWC will provide local participation, Julie Kelley and James Gaumer. While on-site co-principal investigators will have authority to adapt to changing local conditions. Because safety will be a high priority, Reclamation and DCWC will meet to determine activities that will not be allowed during this research. All field workers will be advised of these policies, and provided a Job Hazard Analysis (JHA). Field supervisors will systematically enforce these policies.

Laboratory tasks will be under the supervision of Reclamation, the research hydraulic engineer, Joe Kubitschek, and the principal investigator.

Outreach work will be under the supervision of the DCWC. The Education/Outreach Director of the DCWC, Joan Hemsted, will have final decision-making authority for outreach tasks.

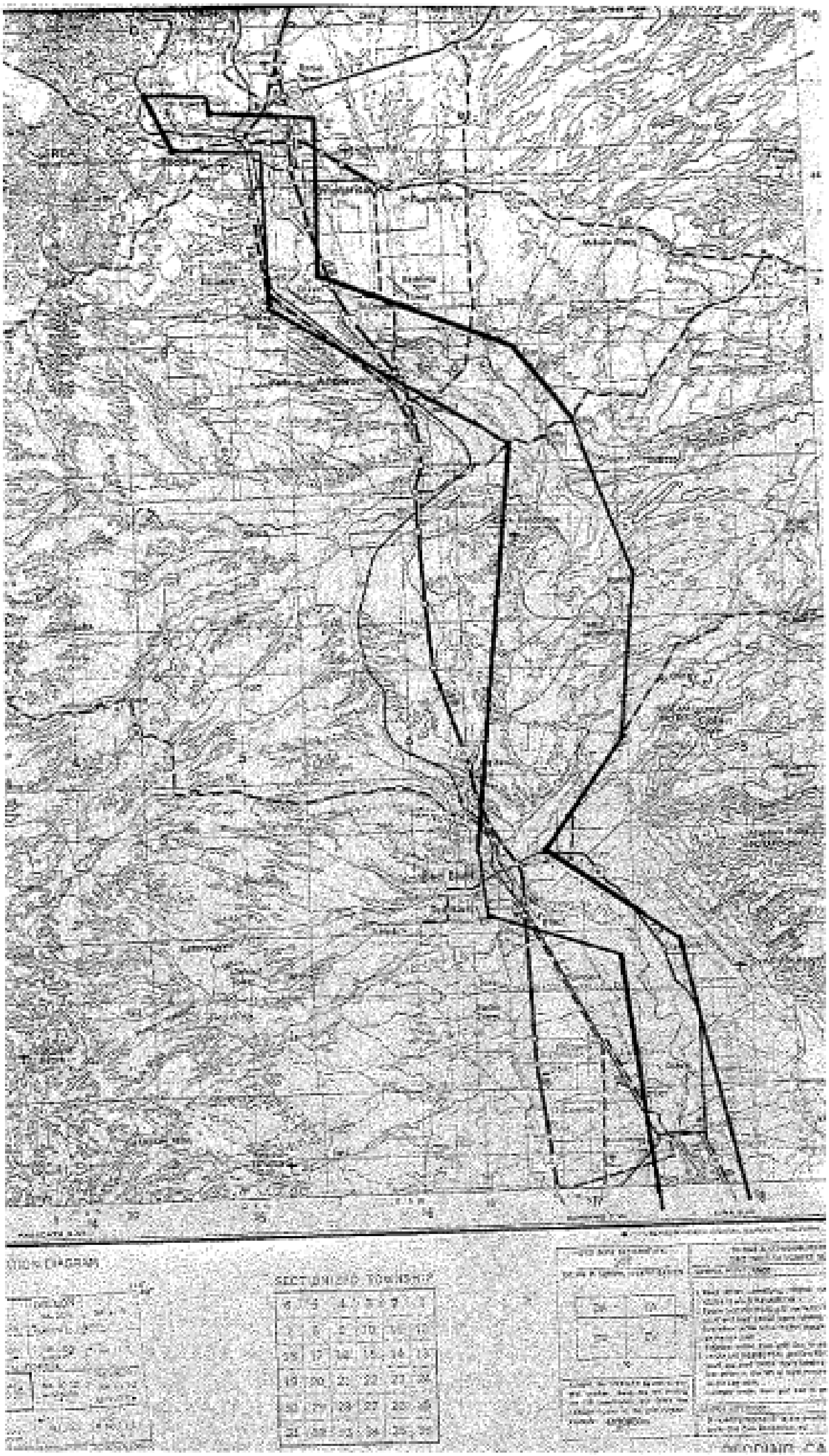
Liability for employees safety and health resides with the respective employer. Liability for report deadlines, accurate accounting, and payments resides with Reclamation.

ATTACHMENT L

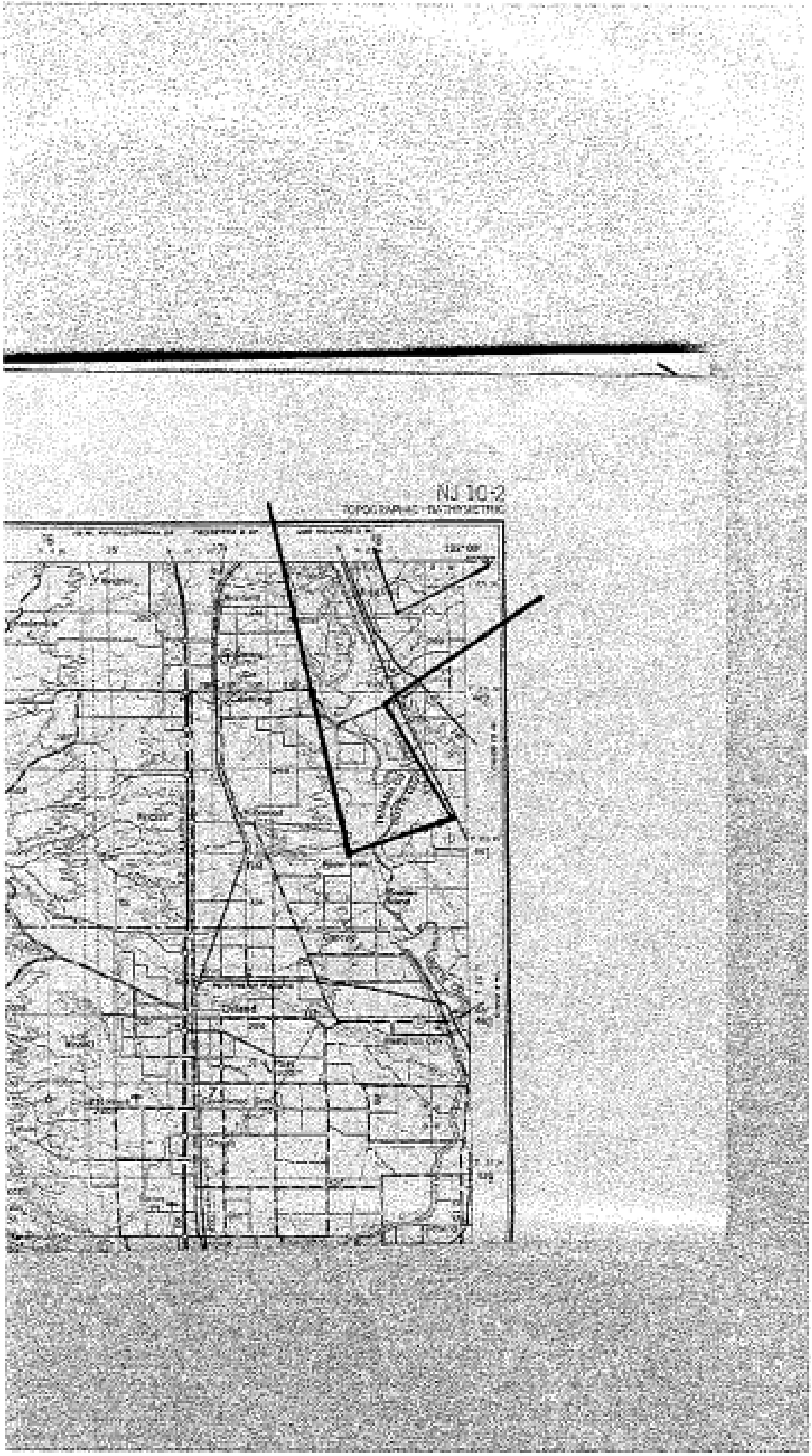
MAPS, COLOR

MAPS, BLACK AND WHITE FOR REPRODUCTION PURPOSES

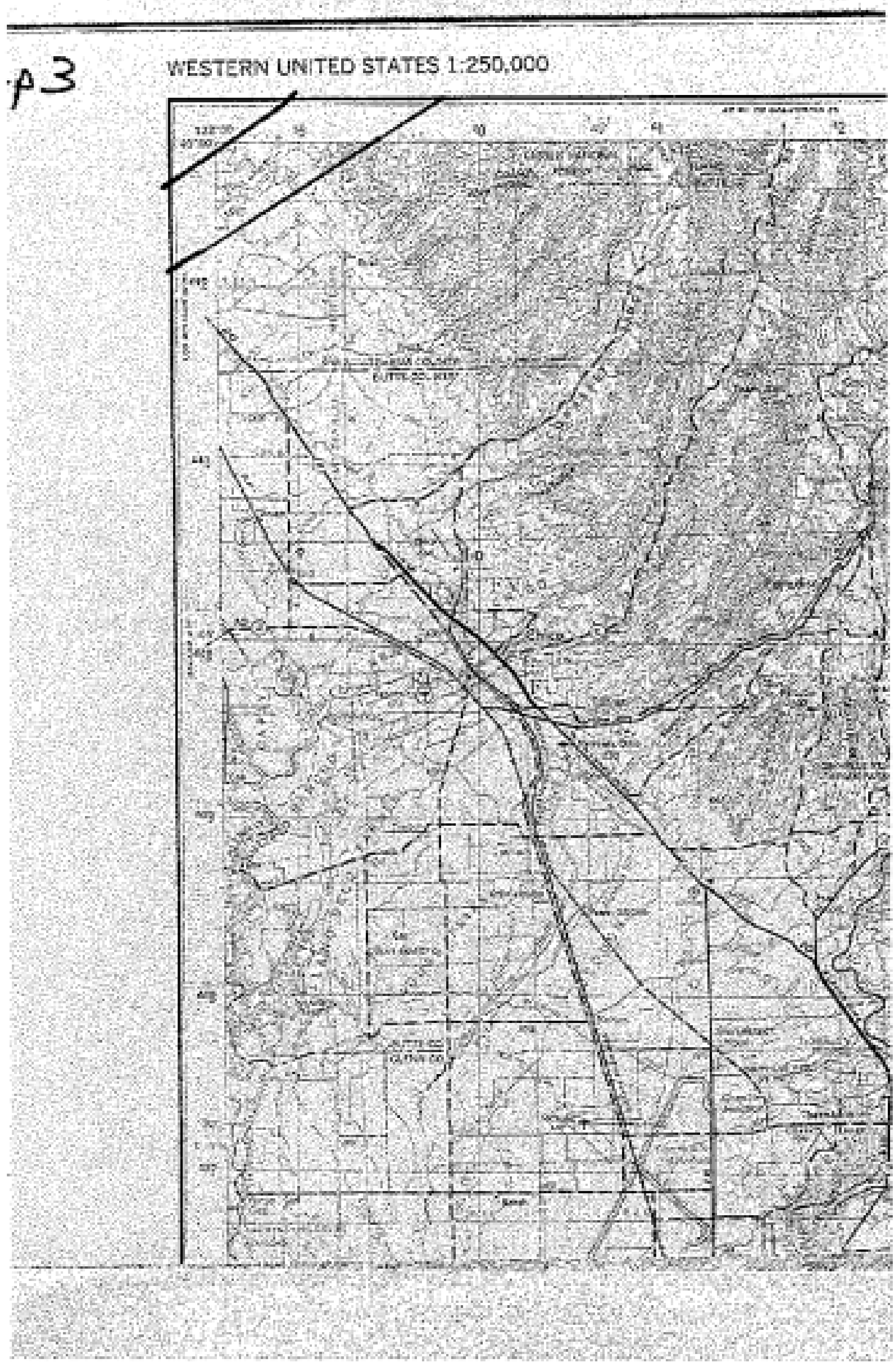
MAP 1



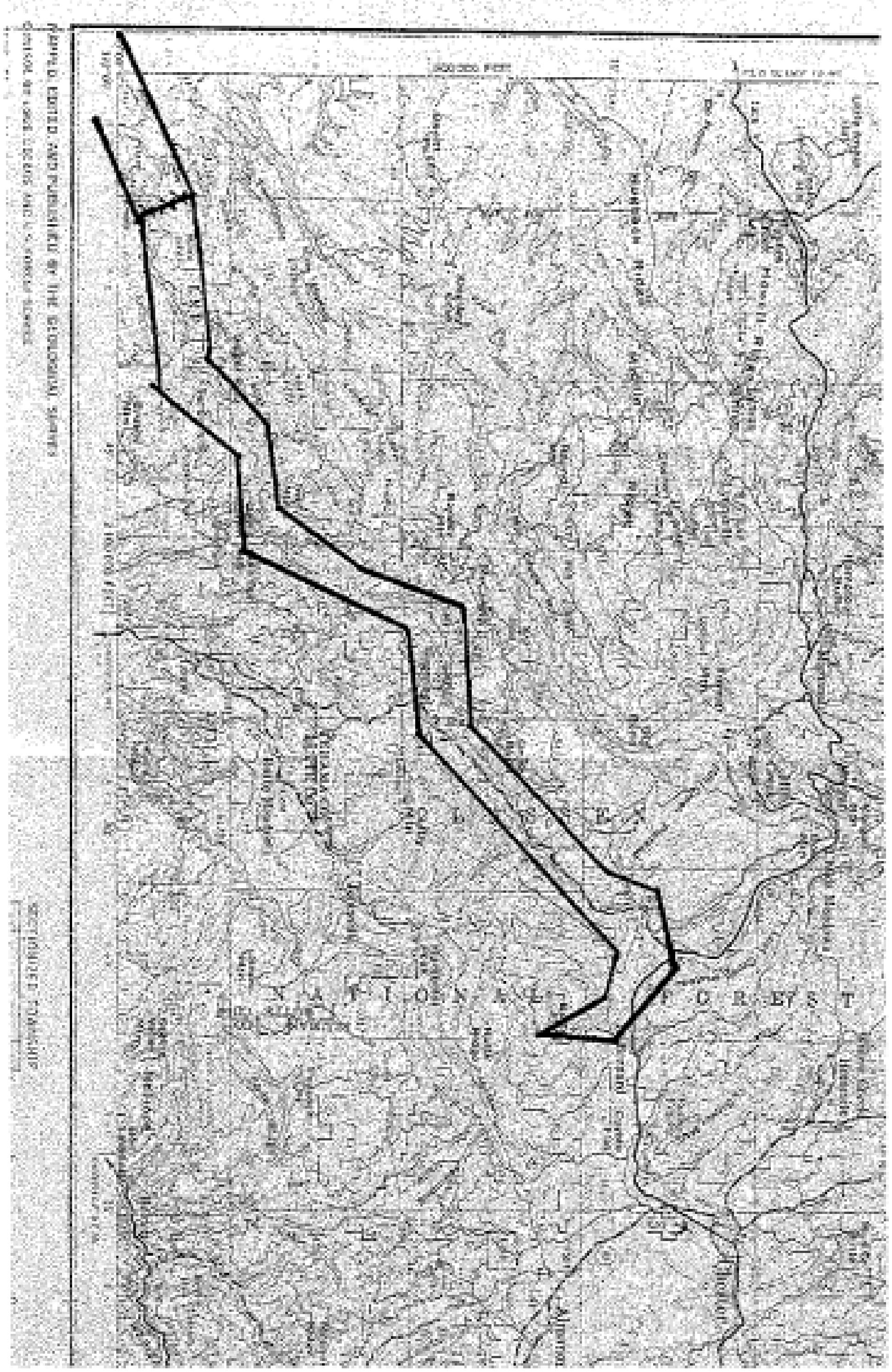
MAP 2



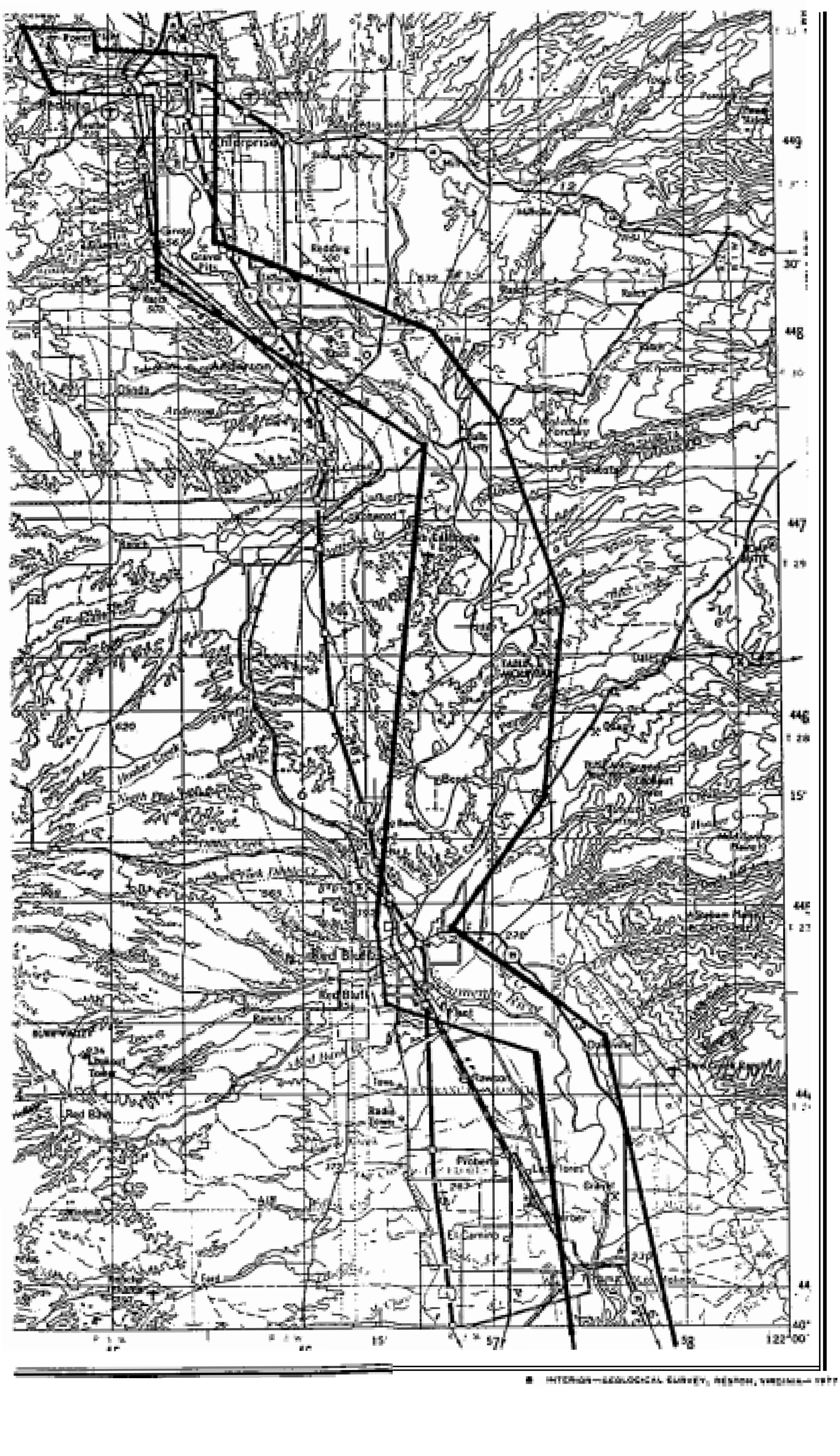
MAP 3



MAP 4



MAP 1

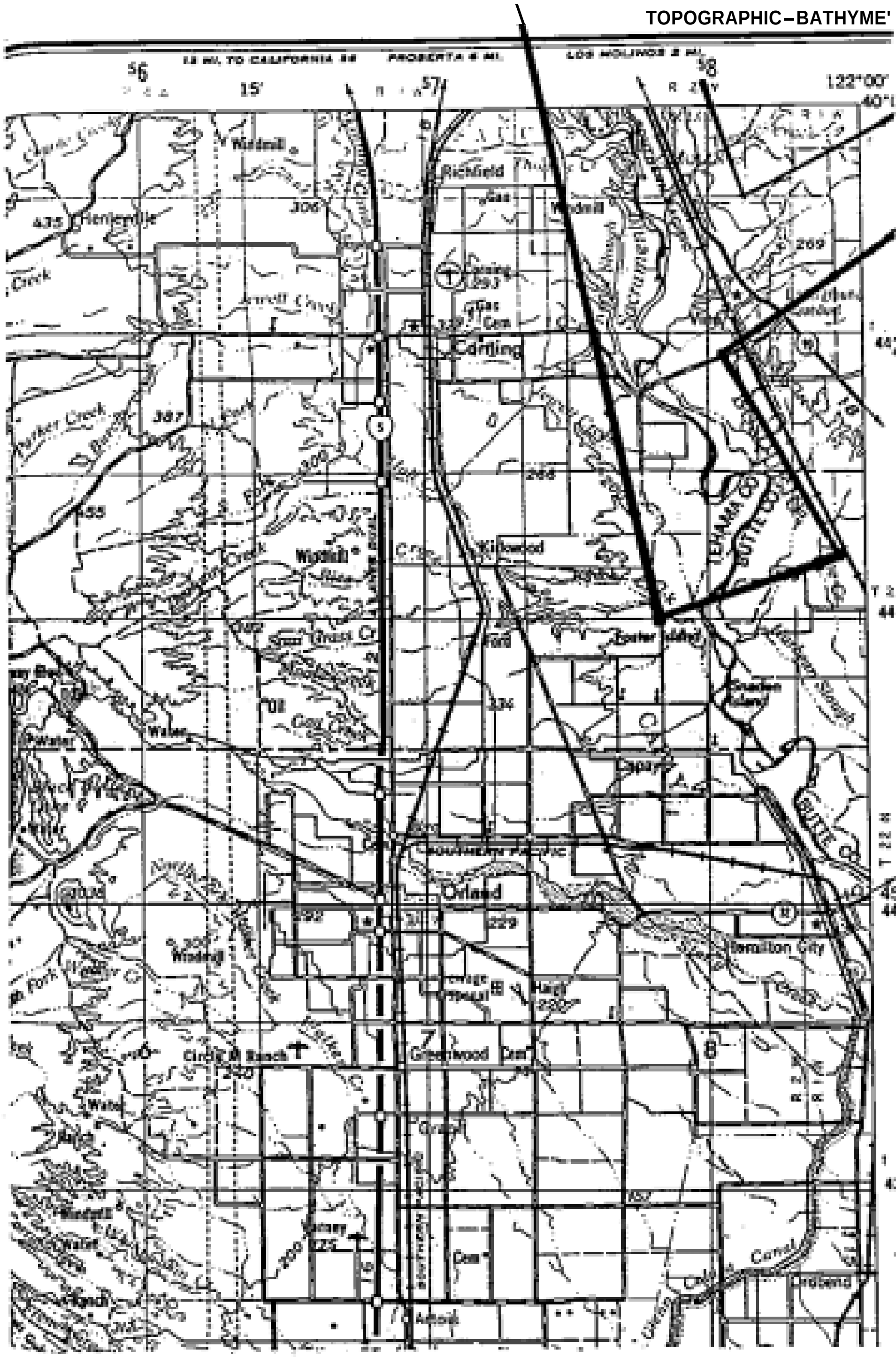


Enterprise
Red Bluff
Anderson
Cottonwood
INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1977

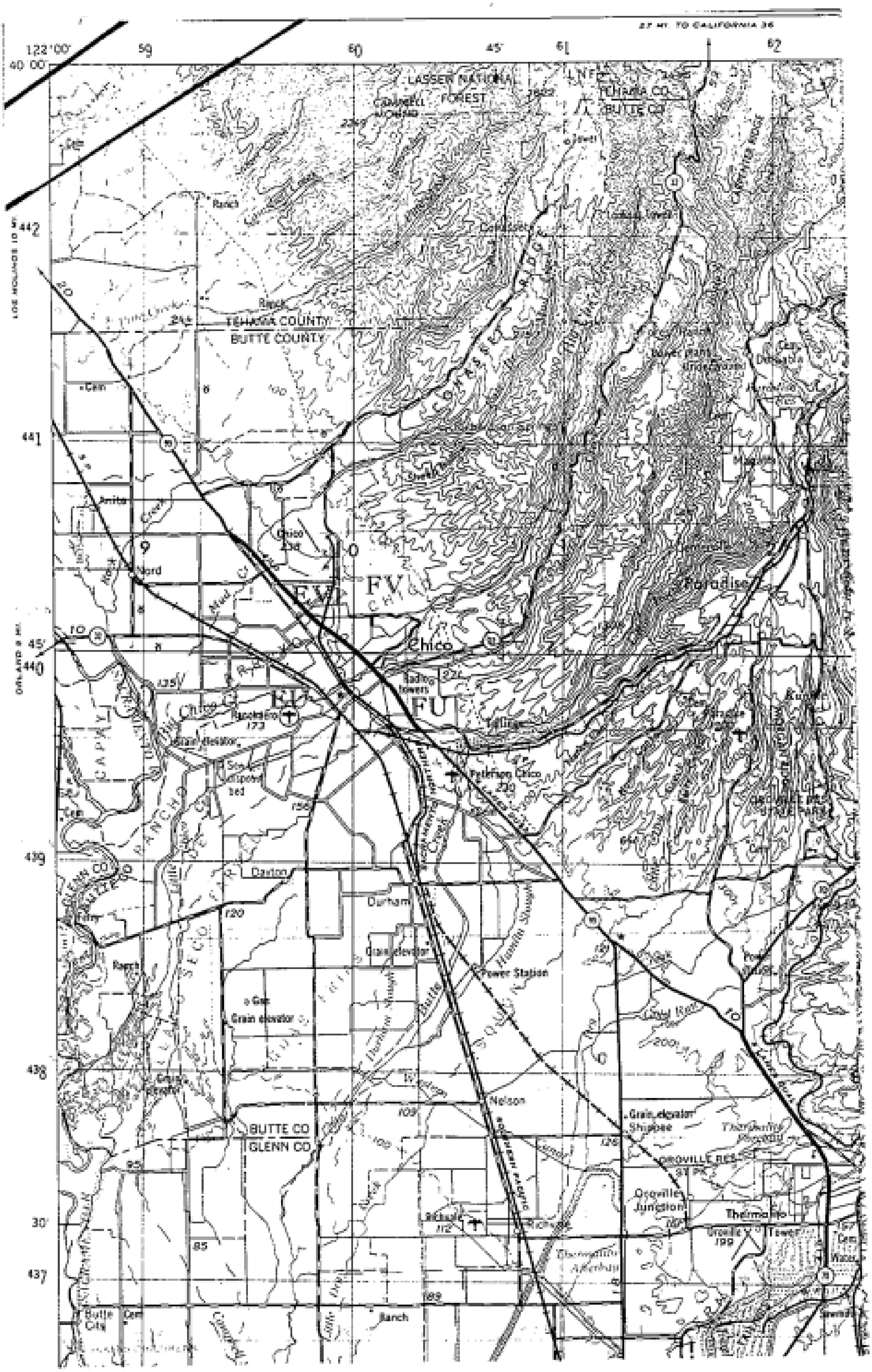
MAP 2

NJ 1(

TOPOGRAPHIC–BATHYME'

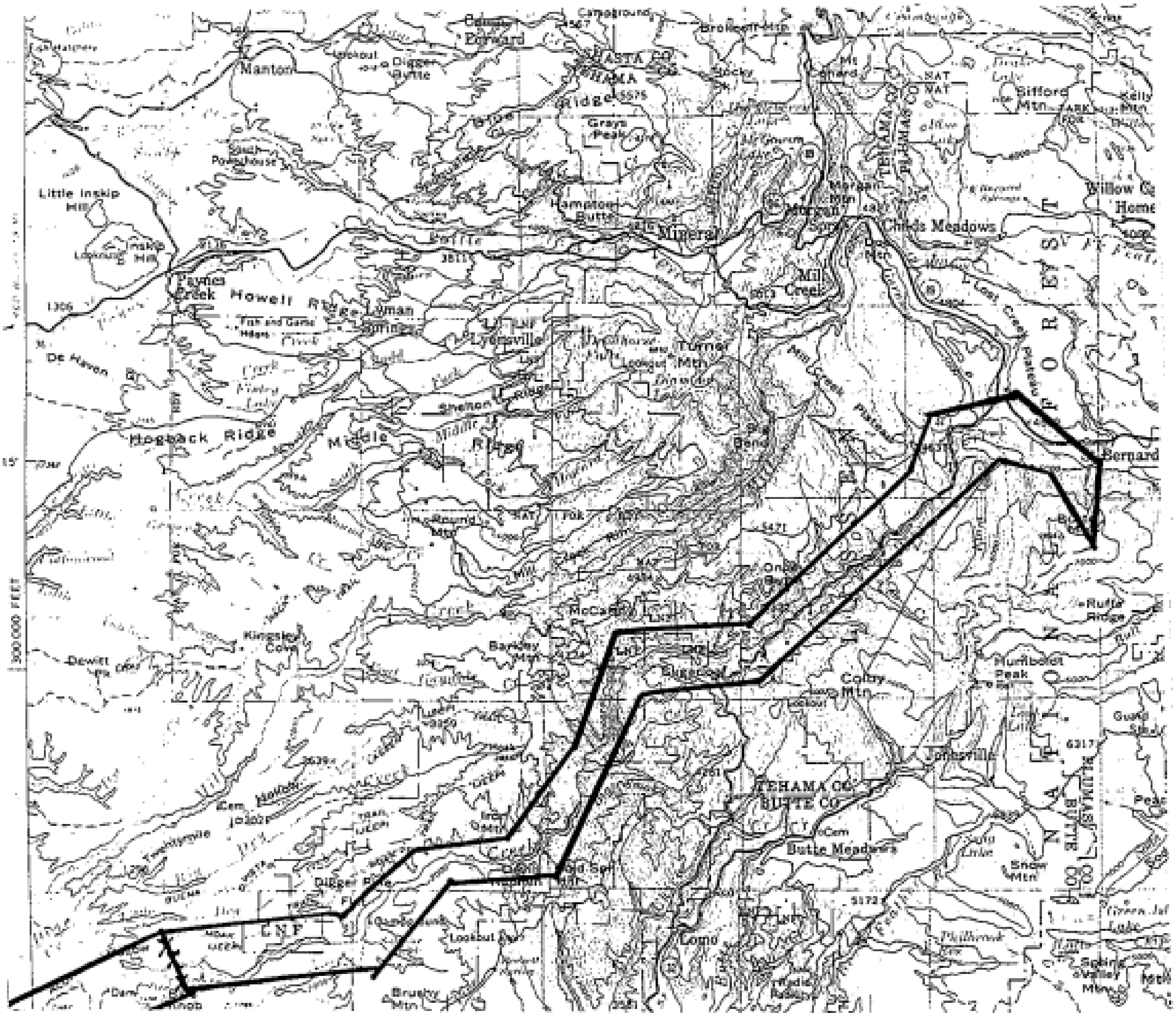


MAP 3



LASSEN NATIONAL FOREST
TEHAMA CO
BUTTE CO
TEHAMA COUNTY
BUTTE COUNTY
Chico
Paradise
Nord
Durham
Dayton
Nelson
Shippee
Oroville Junction
Thermalito
Power Station
Grain elevator
BUTTE CO
GLENN CO
Butte City
Richvale
Ranch

MAP **4**



Manton
Digger Butte
SHASTA CO
TEHAMA
Grays Peak
Little Inskip Hill
Inskip Hill
South Powerhouse
Hampton Butte
Mineral
Morgan Mtn
Morgan Springs
Childs Meadows
Sifford Mtn
Paynes Creek
Howell Ridge
Lyman Springs
Lyonsville
De Haven
Mill Creek
Turner Mtn
Lost Creek Plateau
Hogback Ridge
Middle Ridge
Round Mtn
Bernard
Ruffa Ridge
Kingsley Cove
Barkley Mtn
Dewitt
Colby Mtn
Humboldt Peak
Jonesville
TEHAMA CO
BUTTE CO
Butte Meadows
Snow Mtn
LNF
Brushy Mtn
Lomo